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OBITUARY
PROFESSOR DR. IMRE HORVÁTH

We are deeply grieved to bring to the knowledge of readers of the Acta Biologica Szegediensis that Professor Dr. IMRE HORVÁTH, Academic Doctor of the biological sciences, Head of the Department of Botany in the Attila József University, departed on 16 September, 1979, at the age of 53. We lost in him the renowned teacher of the Hungarian botany, the prominent organizer of the university training of biologists, the excellent researcher of plant ecology, the active devotee of the environmental and nature conservation,
a successful organizer of science of the town Szeged and Hungary.

IMRE HORVÁTH was born in Hódmezővásárhely on 4 September 1926, in a humble artisan family, full of quiet love. From his native town, with an excellent secondary-school diploma, he got to the University in Szeged, where he was admitted as a student reading biology-geography. Working hard at his studies, he participated in the youth-movements of the day, as well, and already as a youth leader he gained experience as an organizer and leader. In 1950, he graduated in natural history — geography; becoming a qualified secondary-school teacher.

As an undergraduate, he got a hard-working, good master. Under Professor PÁL GREGUSS, at the Department of Botany, he acted as an undergraduate assistent, charged with, and having an opportunity to join in, the research work into the xylotomy of Pinaceae.

As a young graduate, he got to the Hungarian Academy of Sciences, reorganized in that time, where he worked in different spheres, among others like as a special secretary, a head of a department of the National Postgraduate Degree Granting

Board, as well. He could only continue more effectively his research work for a higher degree as an aspirant — begun by him already earlier — in 1954. The leader of his aspirant work was Academician REZSŐ SOÓ, professor of Budapest University. But he did not leave in lurch pines, either, during these works. In 1958, he defended his thesis for a candidate's degree, entitled Theoretical problems of growing pine seedlings, with success.

From 1956, he worked as a research worker in Szeged, in the Institute of Climatology. From Professor RICHHARD WAGNER he learned how to operate the meteorological measuring instruments, became acquainted with methods and importance of measuring microclimate, as well as with the climatic and microclimatic factors, having an effect on plants.

In 1958, he was appointed to reader in the institute of Botany of the University of Agricultural Sciences in Gödöllő. Parallel, he was also the section secretary of the Academy of Sciences in biology. He learned, how to deal with several people, different kinds of teaching and research works.

When he was appointed to Szeged, on the Chair of Botany of the Attila József University, in 1965, first as a reader and head of the department, then — after obtaining the degree of Academic Doctor in biological sciences — as professor of university, after what had gone before, he was in possession of all the knowledge, connections, organizational experiences, ideas, and perspective plannings, which — creating a fresher atmosphere — could for a long time give a new profile to the Department of Botany, which had been in possession of other national and international scientific connections.

It was a new colour in his teaching that he wanted, with success, to give ecology a stronger accent than it was in the time of his predecessor. Instead of a plant geography of overwhelmingly coenological aspect until then, more up-to-date autecological points of view of environmental and nature conservation came into prominance in teaching the subject plant- ecology, resp. environmental biology.

In the Botanical Gardens of the Attila József University, he vigorously began to develop the spontaneously formed parts of the garden, to mechanize horticulture, in order to develop the garden, apart from the points of view of the instruction, into a scenic spot, a basis of foreigners visiting the place. He provied the garden with a laboratory, glass- and foil-houses, concrete paths and lighting, in increasing it by about one-third part, by means of grants. There he introduced, with help and co-operation of his co-workers, among others some didactic collections. But he could, unfortunately, not live to see all of these growing up.

The Botanic Gardens of our University became during IMRE HORVÁTH's short direction, lasting not even for 14 years, an important basis of instruction and education in the southern part of the Great Hungarian Plain, which is indispensable for the botanical instruction in the University, spectacular for tourists and the inhabitants of Szeged, and important both in its content and esthetically.

When IMRE HORVÁTH came to Szeged as a professor, the preferred domain of his research work was to investigate into the effect of light upon plants, the dry-matter production of plants, their growth and development. He also obtained the degree of Academic Doctor in biological sciences with his thesis entitled. The effect of the spectral composition of light on the organic-matter production (1968). Initially, he made his experiments with foil tents, electric discharge tubes mounted into thermostats. Later on, his laboratory was built in the Botanic Gardens according to his

plans, and the phytotron with four air-conditioning chambers. IMRE Horváth made the phytotron of the Botanic Gardens suitable for carrying out almost every experiment that was performed abroad with phytotrons of several millions value, being not only a designer but also the mechanic of his instrument. In the self-designed phytotron, he carried out experiments in connection with his investigations into the effect of the spectral composition of light, the change in light energy, the different light-dark rhythms on plants. In his research work, although its basic-research character is not questionable, he was led by practical points of view, as well. He was led by the aim of achieving a larger organic-matter output, a faster ontogenetic cycle, a richer production of useful matters.

The research into the connections between light effect and dry-matter production and the investigation into the methodologies connected with photosynthesis induced him to participate in two themes of the COMECON and he was the coordinator of these themes in Hungary, to international satisfaction.

Owing to his ecological activity, and as a result of the death of the zoologist Professor GÁBOR KOLOSVÁRY, he took the lead of Tisza research. As a good organizer, he organized the research work, which hardly exceeded the frames of Department until then, being mostly limited to some summer expeditions, on a broader basis. As a result of his activity, the Tisza research today embraces the complex biological and hydrological investigation into the whole of the Tisza valley. He could convince the Soviet party in the north and the Jugoslav one in the south and draw them into this work. The biological research into the Tisza today keeps in evidence about fifty researchers. Their activity was published in the annual Tisza-Research Conferences, organized by IMRE HORVÁTH, and in the journal Tiscia, compiled by him.

Within the Tisza Research, there were some problems that turned his interest towards the works of environmental and nature conservation. He patronized, investigated more than one area, made these declare protected or to be a protected site, nature conservation area. These were destined for preserving some ancient parts of his beloved Great Hungarian Plain for Posterity, which parts have been and are sentenced to a slow decease owing to Tisza control, no or inadequate treatment, the modern agricultural technology, eutrophicaton due to an unjustifiedly too much fertilization, without a reconstruction and an effective protection.

His activity is indicated by more than 100 scientific publications, science- and education-political papers, a university lecture note, but his true element was action, a series of actions. This was the life of Professor IMRE HORVÁTH and his life-work, uncompleted and all the same rich in results. We mourn im him the at present still immeasurable organizing individuality of educating work, of ecology and of nature conservancy of the Tisza region.

DR. PÁL SIMONCSICS

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- Вляние краткоритмичного освещения на содержание углеводов фасоли. — Тезисы Докладов 13-ое научное координационное совещание и симпозион по тем 1—18. I. ДУЩАМБЕ, 1977.
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10 YEARS' RESEARCH WORK AT THE DEPARTMENT OF ZOOLOGY (1969—1979)

In the first 50 years of the University having moved in 1920 from Kolozsvár to Szeged, in the Departments of General Zoology, Zoomorphology then of Systematics, professors ISTVÁN APÁTHY, JÓZSEF GELEI, BÉLA FARKAS, AMBRUS ÁBRAHÁM and GÁBOR KOLOSVÁRY, together with their research workers, carried out generally recognized neurohistological, protistological, histological physiological and taxonomical investigations. In 1969, in the united Department of Zoology, besides the above-mentioned ones, the domain of entomological research was also introduced. By the change in profile ten years ago, the educational work of the department was also favourably affected. By means of the most modern 35 audiovisual slide-units, developed in the meantime, with 80 slides each, and the tape recorded texts belonging to these, as well as of the cinematographic colour film materials, amplified partly with sound and made by ourselves, the education have been raised up to the forefront, even beyond our frontiers.

In the meantime, the number of lecturers and research workers has, unfortunately, not increased, at best, with the passage of the years, they were, of course, partly substituted. In 1969, there were active in the Department: six lecturers (Dr. FERENC BICZÓK holder of a candidate's degree, reader, Dr. ANDOR HORVÁTH holder of a candidate's degree, reader, Dr. MAGDOLNA FERENCZ senior lecturer, Dr. IMRE HORVÁTH senior lecturer, Dr. MÁRIA CSOKNYA senior lecturer) and four researcher (Dr. JÓZSEF KORMOS holder of a candidate's degree, senior member of the Institute, DR. ARANKA STAMMER holder of a candidate's degree, reader, Dr. DÁNIEL GÁL research fellow, Dr. JÁNOS GAUSZ junior member), in 1979 there were eight lecturers (Dr. IMRE HORVÁTH holder of a candidate's degree, reader, Dr. ARANKA STAMMER holder of a candidate's degree, reader, Dr. MÁRIA CSOKNYA senior lecturer, Dr. MAGDOLNA FERENCZ senior lecturer, Dr. LÁSZLÓ GALLÉ senior lecturer, Dr. KATALIN HALASY research assistant, Dr. ERZSÉBET HORNUNG contractual research assistant) but only two researchers (Dr. DÁNIEL GÁL research fellow, Dr. GYÖRGY GYŐRFFY junior member) were on active payroll. It belongs to the efficiency of our work that approximately thirty persons took their doctor's degree of our special subjects, one became the holder of a candidate's degree in biology, the applications of two for a candidate's degree are under way. The lecturers and rese-

archers of the Department published 214 articles during these ten years, on 4267 pages. Of these, the number of general and popular scientific publications is 47, in an extent of 1220 pages. On the other hand, scientific results are contained in 167 papers, in an extent of 3047 pages. The development of entomological researches is indicated by the 77 publications on entomological subject, made overwhelmingly by four entomologists on 1340 pages, by the abstracts of three lectures, as well as by 33 audiovisual units (each 80 slides) by one volume of lecture notes on ecology, this with a content of 211 pages, as opposed to the fifty publications of the Department on histology, protistology and hydrobiology on 875 pages, to 37 abstracts of lectures, as well as to 2 audiovisual units by, to six volumes of university lecture notes on 388 pages.

In the Department, apart from the research work on systematics, ecology and ethology, referring mainly to entomology, the previous researches on protistology and morphology have, of course, also been continued. Mentioning only the outstanding results: one of the investigations on protistology is that of the photoinduced motion phenomena of *Tetrahymena pyriformis* L. G. sensitized with xanthin stain. There were observed well-perceptible connections between the effects of O_2 consumption, the speed of movement, the photo-oxidation-induced electron-microscopic structural (mitochondrial) changes, as well as those of ATP, temperature, the enzyme inhibiting and reactivating agents (BICZÓK). By other investigations in protistology the interpretation of the energetic processes taking place in the rhizosphere were approximated (BICZÓK).

There were carried out surveyings on the Rhizopod fauna of the river Tisza, the zooplankton of the Tisza reaches above Kisköre. In the zooplankton of the Tisza Dead-Arm at Kisköre two maxima were observed annually. Below Szolnok, the Tisza proved to be of meso-saprobic character (GÁL). Similarly, at investigating the water ecosystem, the alkali lakes were classified on the basis of the dominant taxonomical groups of zoobenthos (Ceratopogonida, Chironomida and Oligochaeta) and other abiotic factors into groups and the verticaldist ribution of zoobenthos was examined (FERENCZ). From the waters of the rivers Tisza and her tributaries, on the basis of examining hundreds of samples, 64 species were demonstrated from the Cnidaria, Kamptozoa, Platyhelminthes, Annelida, Tentaculata and Arthropoda, and established that the heaping of alluvial deposit (before and after impoundment) is connected with the increasing of the individual numbers of the detritophagous annelids (FERENCZ).

In the cyto-genetic researches belonging into the domain of bioregulation, the investigation into cell organization took a part. The pharyngenial types of Gymnostomata could be delimited (KORMOS). We have described the simple and composed infraciliary structures, mainly in the groups Oligotricha and Gymnostomata, and characterized the full series of the types of the cellular proliferation (KORMOS). The ontogenetic and phylogenetic organization of Ciliata was also outlined (KORMOS).

Comparative neurohistological investigations have been continued by the students of Professor AMBRUS ÁBRAHÁM who is now as a professor emeritus extremely active. The researches on receptors were closed in 1973 (STAMMER). In the course of studying the hormonal system and neurosecretion, the connections of the sympathetic nerve in the innervation of the pineal body of the pigeon and bat could be neuromorphologically demonstrated (STAMMER). In the sections of the digestive tract of the different frog's species some differences characteristic of the species, in the

histological layers of the heart and in the vegetative ganglia so far unknown nerve terminals have been demonstrated (HORVÁTH). The effects of water pollution were observed by studying the gills and kidney of fishes. We have observed the destruction of mitochondria, the accumulation of lysosomes and the appearance of the most different membrane configurations (STAMMER—HORVÁTH). The respiratory epithelial cells of the fish's gill, the cells of the kidney, the chloragogenous cells covering the typhlosolis of the earthworm are considerably damaged by hydrogen sulphide (HORVÁTH). Studying the innervation of the digestive tract of birds, we have described pressure sensitive receptors (CSOKNYA).

In the course of the taxonomic-faunistical researches, the monographic elaboration of the Hungarian recent and Pleistocene Mollusca and the summary of several ecological observations were, unfortunately, prevented from being concluded by the death of the author (A. HORVÁTH) in tragic circumstances.

In the last ten years, the following researches on entomology were going on at the Department.

Between 1969—1972 we participated in a detailed exploration of the animal kingdom of Hungary, the elaboration of the world material of taxonomic units and in complex auto-ecological and ethological researches. From 1972, we have mainly worked in the main direction at ministerial level, taking place in the plan of the Hungarian Academy of Sciences, in the theme: Protection of man and its natural environment (biosphere). These are: I/ Comparative researches into the terrestrial ecosystems, divided into two branches: the first one is the analysis of the natural, modified and cultural ecosystems, taking into consideration structures, function, energy flow and productivity. II/The second theme investigated into the regularity of the supraindividual organization going on in the biosphere, mainly in nature reserves. The Department has dealt with the latter theme at the level of ecosystem. Theme II is the research into water ecosystems, with regard to the Tisza I and II river barrages.

The Department was entrusted in contractual way by the Hungarian Academy of Sciences with elaborating the following theme between 1978 and 1980: "Animal-ecological investigations in the area of the Kiskunság National Park, in the *Astragalo-Festucetum rupicolae (=sulcatae)* ecosystem".

In the above themes, we could achieve the following outstanding results. In the area of taxonomy-faunistics: In the Academic series: Animal Kingdom of Hungary, fascicle Tenthredinoidea I, the division of subfamilia Ichneumonoidea and its fascicle IV were finished, partly by co-authors (MÓCZÁR). The new ant genus Sifolinia and two new species could be demonstrated from this country (GALLÉ). The animal identification handbook of the species Hymenoptera and Odonata in Hungary was finished (Móczár). With the cooperation of Slovak-Romanian-Jugoslavian-Ukranian-Austrian researchers, the interlingual list of the new Hymenoptera habitats of the Carpathian basin was made according to the zoogeographical map published in the National Atlas of Hungary (MÓCZÁR). The full elaboration of the world material Mesitinae was published, containing seven new genera and 51 new species for science (MÓCZÁR), as well as the elaboration of the materials Pompilidae, Chrysididae, Ceropalidae from the Mongolian, Southern-Asian expeditions (MÓCZÁR). The material of the world catalogue of Ceropalidae is ready in 70 per cent (MÓCZÁR).

In the domain of the complex auto-ecological-ethological research work, we ha-

ve demonstrated the climatic factors inducing daily activity rhythms of *Paragymnomerus spiricornis* (temperature, humidity), the micro-climatic peculiarities of the loess-wall serving as nesting site and determined the special features of the connection between the environmental factors and the wasp population. The detailed developmental cycles of the wasp population, several conducts of the life in groups, pointing at the beginning of social life, as well as some moments of the regularities of a supraindividual organization were cleared up (MÓCZÁR—GALLÉ).

In the field of the research of terrestrial ecosystems, the analysis of the insect population of hemp began; investigations into the Orthoptera population were carried out in the flood-plain of the Tisza, in alkali, sandy areas (GAUSZ).

At the structural and functional investigations into the insect communities of the agricultural ecosystems, after elaborating approximately 50,000 insects, the specific composition of the nutritive plant association of condiment paprika, the relations of dominance and abundance, the mutual relation between the groups of the way of life became elucidated. On the basis of the proportion of the entering and leaving species representations, as well as of their activity, we could separate the seasonal aspects of the nutritive plant associations from one another. The kinetic activity, population activity, the seasonal dynamics of the single species were clarified (GYŐRFFY).

From among the natural, resp., partially modified ecosystems, we have dealt with the Formicoidea species communities of the Tisza valley, characteristic mainly of grasses, as well as the physical environmental conditions and biological interactions, taking part in the regulation of the single populations. These investigations are particularly important in revealing the competitive effects between populations and within the populations. We have also studied the ecological energetics of some important ant species of the grasses along the Tisza. In the course of the field and laboratory investigations, it was demonstrated about *Formica pratensis* that the rhythm of its foraging activity was induced by exogenous factors. A colony of many netss consumes 11—23 kg food a year (dry weight), passing it with 1.6 per cent efficiency to the next energy level; *F. pratensis* can be used for the biological protection of the pine plantations. In this case, the efficiency of its use can be increased with guard-nets. We have demonstrated a special mechanism in the temperature control of nests as well (GALLÉ). On the *Formica* and *Lasius* species a group-effect was observed. In these individuals the parameters of the consumption of food and respiration change and, likewise, the productivity at group and individual levels also differ. We have determined the composition of ant communities characteristic of the single grasses and estimated the density of the single populations (GALLÉ). In the abovementioned natural ecosystems in the environs of Szeged, the macro-decomposing Isopoda fauna of grasses was studied. The role of an Isopoda *(Trachelipus nodulosus)* and a Diplopoda species *(Chromatoiulus unilineatus)* in material and energy flow was cleared up. We have investigated into the effect of the outer environmental factors on the parameters of energy flow and demonstrated particular differences in acclimatization between these species (HORNUNG).

In the water ecosystems, first of all in the Tisza and Maros, the larval phases of *Palingenia longicauda* and, partly, the factors influencing the distribution of other Ephemeroptera and Odonata larvae, like a change in water level, water pollution, the study of oxygen content, are of entomological relation (CSOKNYA). It was established that the oxygen consumption of the young *Palingenia* larvae counted for

unit body-weight is higher than that for the consumption of old larvae. These values are further affected by the lack of light, substratum and the increase in temperature (HALASY). The streamline of the Tisza is optimum but the distribution and last-year development of *Palingenia* larvae are affected by a frequent and higher than one metre fluctuation of the level of water (HALASY). It turned out at the electron-microscopic scanning examination of the tracheal branchia that on these, in addition to the characteristic respiratory epithelial cells, there are probably some peculiar cell-groups, as well, being probably osmoregulative or receptor cells (CSOKNYA). From the zoobenthos of the Tisza several Ephemeroptera species were demonstrated, too (FERENCZ). In the zoobenthos of the waste-water canals, Diptera larvae (Ceratopogonidae and Brachycera) were dominating (FERENCZ).

With the grass-ecosystem investigations the Department of Zoology initially wanted to co-ordinate the terrestrial ecological investigations in some sites in the vicinity of Szeged (Ásotthalom, Körtvélyes, Kiskundorozsma), developing these further into a complex investigation in the framework of a uniform ecosystem. At the same time, our Malaise-trap investigations, carried out for years in these areas together with other examinations, played only a minor role. About the latter before hand only so much that the elaboration of more than 20,000 insects, collected in the course of 20 sampling during three years, is under way.

After informative surveys, we began the research in the Kiskunság National Park, in March, 1976. Our work was supported by the directors of the Kiskunság National Park, in addition to marking out the area, in both professional and technical fields. In the area of Kisbugac, on two hectares, a less pastured grassland, close to nature, was marked out for researches.

By a complex investigation into the grass ecosystem we understand both a methodological and a thematical complexity. In this sense, our aim is to reveal the structural characteristics of the grass ecosystem and their key-processes. We cannot undertake, of course, to draw every detail of these which are not too important from the point of view of the full working and regulation of the system (e.g., the specific quality of the populations of very low individual number having a part in these) or every part process (e.g., the determination of the energetic parameters of a population having an insignificant part in the material and energy flow) into the circle of our investigations.

We have approached three levels of the system; these are:

(1) The faunistical-ecofaunistical level. This is, in fact, the qualitative revelation of the specific quality of the population forming the zoocoenosis. For this, we have applied special instruments of collection, like the Malaise traps, introduced by the author in this country, in the same way, the covering traps, having been shown us at the ecological investigations in Tyrol. These function night and day continuously and give an insect material which is suitable for a comparatively high faunistical and ecofaunistical evaluation. These data are of real value in respect of the insect fauna living in the investigated area and reliable on its seasonal dynamism. The elaboration of this enormous material (about 98,000 insects) is also under way.

(2) By examining the structure-coenological level, we have expected some inforpmation on the construction and henomenology of biocoenosis.

(3) When investigating the functional ecological level, we have intended to clear up the part of the single members of biocoenosis in the trophic network of biocoenosis. At the same time, we have expected some information of the most im-

portant mechanisms of the regulation of the single energy levels and dominant populations and of the regulation of the whole system as well.

The study of the structure-coenological level and still more of the levels of energy flow and regulation demands a very large researcher team not only for surveying the place but also for elaborating the material. As this great task cannot be carried out by the four entomologists (lecturers and researchers) of the Department of Zoology, we are performing this work by drawing into the work two zoologists, resp. entomologists, Dr. LAJOS TANÁCS and SÁNDOR KOVÁCS, as well as some undergraduates. On the part of the Department of Botany, of the Attila József University in Szeged, the botanical field work is carried out by two undergraduates. The phytomass and its microclimatic measurements are, at the same time, the essential conditions of our investigations, as well. In addition to these, six undergraduates from the study group were also engaged in our work. Between 1976 and 1978, during three years, we worked all in all 292 days in the field, collecting in Bugac, during this time, more than 100,000 insect specimens.

In the course of our research work, apart from studying grass under natural conditions, in 1978 we also initiated to investigate into grazed grasslands drawn under human activity. After finishing the full theme, we hope to get some information, not only on the natural grass-coenoses but also on the ecological systems of anthropogenous regulation, in the possession of which we shall perhaps be able to render help to the most suitable and economical setting of the parameters of these.

Publications of the members of, and fellow-workers at the Department of Zoology and some outstanding educational publications between 1969 and 1979 are the following:

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EFFECTS OF CERULENIN AND PYRIDAZINONE HERBICIDES ON THE GREENING OF BARLEY LEAVES UNDER A LOW INTENSITY OF LIGHT

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Abstract

Fluorescence spectra of barley leaf samples, incubated for 18—20 hours at 25 °C with cerulenin or with the pyridazinone herbicides SAN 6706, SAN 9789 and SAN 9785 in a concentration of 1 mg/g leaves, were taken regularly at −196 °C during greening under white light of 20 or 30 μWcm^{-2} (for cerulenin or SAN, respectively) and are shown 10 min, and 12, 48 and 96 hours after the beginning of greening. The pigment composition was determined via absorption spectroscopy; the chloroplast ultrastructure was studied electron-microscopically.

Cerulenin treatment leads to profound structural changes of the membrane system, accompanied by significynt differences in the pigment contents (the absolute amount of pigments becomes less, while there is a relative increase of carotenoids compared to chlorophylls, and several fluorescence bands are absent). Similar, but less expressed structural changes and alterations in the pigment composition are caused by SAN-treatment. In all cases the biosynthesis of some membrane constituents (fatty acids, carotenoids), and thus the development of a normal organization of the photosynthetic apparatus, is inhibited.

Introduction

Etiolated leaves are very suitable objects for studying the relation between the chloroplast structure and the photosynthetic processes, since the biosynthesis of pigments, proteins, enzymes and other membrane constituents proceeds in parallel with the gradually evolving photosynthetic capacity during the greening of etiolated plants (ARNTZEN and BRIANTAIS, 1975). The biosynthesis of chlorophylls and the formation of in vivo chlorophyll forms during greening can easily be traced, e.g. with low-temperature fluorescence spectroscopy: in etiolated leaves only fluorescence bands at 633 and 655 nm (F633 and F655), characteristic of protochlorophyll(ide)s, can be observed; under illumination other fluorescence bands, characteristic of photoproduced forms of pigments, accompanied by those synthetized in the dark, gradually appear (THORNE, 1971; BOARDMAN, et al., 1970; KAHN et al., 1969; LITVIN and SINESHCHEKOV, 1975). Under normal conditions the pigment states and the environment of pigments are developed after 36—48 hours of greening and the fluorescence spectrum has maxima at about 687, 695 and 740 nm.

Lipids and fatty caids are important and characteristic chloroplast constituents (LEECH and MURPHY, 1977) and it is well known that these constituents differ highly in etioplast and mature chloroplast membranes (ROUGHAN and BOARDMAN, 1972;

TREMOLIÉRES and MAZLIAK, 1970; TEVINI, 1971; SELLDÉN and SELLSTAM, 1976). Important qualitative and quantitative changes should therefore take place in these constituents during the greening process. Cerulenin (an antibiotic produced by the fungus *Cephalosporium caerulens*) has been found to be a specific inhibitor of fatty acid biosynthesis in bacteria (D'AGNOLO et al., 1973), in fungi (OHNO et al., 1974) and in higher plants (WARING and LATIES, 1977), while at the same time it affects the structural and functional properties of membranes in algal cells (LEHOCZKI et al., 1979; HERCZEG et al., 1979) and in chloroplasts of higher plants (SZALAY et. al., 1979). The mechanism of action of pyridazinone herbicides is not well understood, but it seems certain that pyridazinones inhibit the biosynthesis of the lipid constituents of membranes (HILTON et al., 1969; BARTELS and HYDE, 1970; HILTON et al., 1971), and they are considered to be specific inhibitors of carotenoid biosynthesis (BARTELS and HYDE, 1970; BARTELS and MCCULLOGH, 1972; LICHTENTHALER and KLEUDGEN, 1977; VAISBERG and SCHIFF, 1976); according to HILTON et al. (1969 and 1971) and JOHN (1976), they are inhibitors of the biosynthesis of linolic acids and galactolipids.

In order to influence the fatty acid and lipid composition in etiolated leaves and to induce changes in the greening process accompanied by changes in the micromorphologic, spectroscopic and photosynthetic properties, we applied cerulenin and pyridazinone treatment. Our aim was to study the formation of the pigment system during the greening process in correlation with the microstructural changes caused by inhibitors of the lipid biosynthesis of the membrane constituents under extremely low-intensity illumination.

Materials and Methods

Cerulenin[1] (from Koor-Trading, Austria) and pyridazinones[2] (products of Sandoz and denoted briefly as SAN 9789, SAN 9785, and SAN 6706) were used without further purification

Barley plants (*Hordeum vulgare* L.) were cultivated for 7—8 days in the dark and leaves 4—5 cm in length were treated with inhibitors at 25 °C. The control leaves floated in a Petri dish containing culture medium.[1] The cerulenin treatment was performed in culture medium containing 1 mg cerulenin/g fresh leaves. For SAN — treatment, SAN was first dissolved in acetone, the acetone solution was poured on to a filter paper placed in the dish, the solvent was evaporated and culture medium was added to the dish. The amounts of chemicals were adjusted to a final concentration of 1 mg SAN/g fresh leaves. This treatment was carried out under very weak green light. After 18—20 hours of incubation in the dark, greening was initiated under the white light of a tungsten filament lamp of 20 or 30 μWcm^{-2} intensity for cerulenin or SAN treatment, respectively. Very weak light was used in order to slow down the light reactions and to diminish the photodestruction of chlorophylls.

The fluorescence spectra were taken at −196 °C with a Perkin-Elmer MPF 44/A spectrofluorimeter from 600 to 770 nm at 430 nm excitation. The fluorescence spectra were corrected for the spectral sensitivity of the apparatus, and were normalized to maximum intensity.

The pigment content was determined from ethyl ether extracts by the multi-wavelength method of FRENCH (1960), using the absorption spectra of the extracts. Due to the difficult removal of the solution from the leaves, it was estimated that the error of this determination was about 10%.

The electron-microscopic pictures were taken with a JEOL 100B electron-microscope after the usual preparation of the leaf samples (KOVÁCH, 1959).

[1] (2S), (3R), 2, 3-epoxy-4-oxo-7, 10-dodecadienoyl amide

[2] 4-chloro-5-(methylamino)-2-(α, α, α-trifluoro-m-totyl)-3(2H)-pryridazinone: SANDOZ 9789; 4-chloro-5-(dimethylamino (-2-(α, α, α-trifluoro-m-totyl)-3(2H)-pyridazinone: SANDOZ 6706 4-chloro-5-(dimethylamino)-2-phenyl-3(2H)-pyridazinone: SANDOZ 9785

[1] 0,2% Wuxal solution, practically a KNOP solution containing trace elements.

Results and Discussion

Effect of cerulenin on the greening process

The fluorescence spectra of etiolated leaves showed the F633 and F655 bands as expected. Treatment with inhibitors did not cause appreciable changes in the spectra of leaves kept in the dark. However, if the greening starts under weak illumination, the fluorescence spectra become more complex, several bands appear, and in the course of the greening both the location and the intensity of bands exhibit characteristic changes. In addition, cerulenin treatment causes great alterations in the spectral distribution of the fluorescence.

Under low-light conditions an F675 band appears and the F633 band decreases, in agreement with the results of LITVIN and BELIAEVA (1971). After a 10-min illumination, a shift of the bands toward longer waves, an increase of the bands at longer waves, and the appearance of new bands are observed (Fig. 1). In cerulenin-treated leaves these processes seem to be slower: in the control leaves the F683 band develops after a 60—90-min illumination, whereas in cerulenin-treated leaves 10—12 hours is needed; by this time the increase of the F740 band has already started in the control leaves (Fig. 2.A). The development of the final stage of fluorescence spectra is shown in Fig. 2.A—C. After 3 days of illumination the control leaves have a fluorescence spectrum characteristic of normal green leaves; this type of spectrum is obtained only after about 4 days in cerulenin-treated leaves (Fig. 2. C), but even this spectrum is still very different from that of normal leaves. The fluorescence spectrum of untreated leaves has a more expressed structure than that of cerulenin-treated ones. This may be due to the collapse of the membrane structure in lipid-deficient

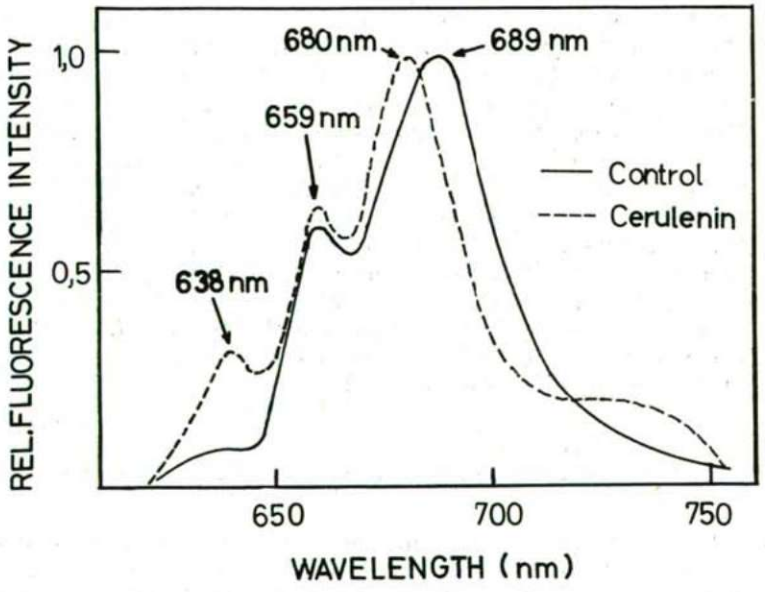

Fig. 1. Fluorescence spectra of control and cerulenin-treated barley leaves after 10 minutes of illumination measured at −196 °C.

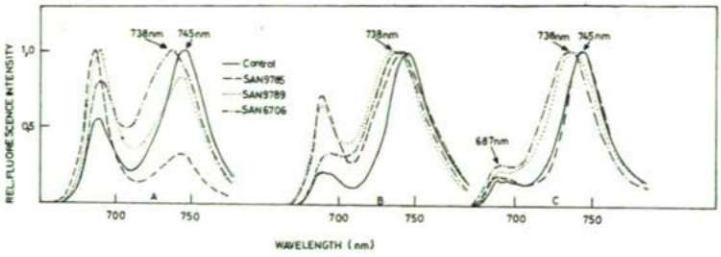

Fig. 2. Fluorescence spectra of control and cerulenin-treated barley leaves after 12 hours (A). 48 hours (B) and 96 hours (C) of illumination measured at −196 C.

cells and the deficiency of fully-developed pigment forms (as an alternative, one can think of the change of the condition of energy migration which can occur in a poorly-organized pigment system). It is worth mentioning that a band apperas around 725 nm in the difference of the spectra of treated and untreated samples shown in Fig. 2.C.

The pigment content is much less in cerulenin-treated leaves than in control leaves; the accumulation of chlorophylls is considerably inhibited, but that of carotenoids is less inhibited by cerulenin (Fig. 3). The ratio chl-a /chl-b is much higher in every stage of greening of cerulenin-treated leaves than in control leaves. The ratio chlorophylls/ carotenoids increases in control leaves and decreases in cerulenin-treated leaves during the greening process (Table 1). The relative increase of the carotenoid content in treated leaves indicates that carotenoids are less sensitive than chlorophylls to the cerulenin treatment. The most striking effect of the lipid deficiency is seen in the ultrastructure of the chloroplasts.

The electron-microscopic pictures of chloroplasts after 4 days of greening show the well-known ordered, lamellar structure; however, due to the low-light conditions the fine structure is poorer in the membranes than for leaves greening under normal, higher-light conditions (Fig. 4). In cerulenin-treated leaves the organization of the chloroplasts is much less: instead of longer stacked lamellae with more or less granal structure, membrane fragments but no grana are present (Fig. 5).

The effect of cerulenin on the greening process under low-light conditions seems to be primarily attributable to the inhibition of fatty acid biosynthesis. Though complete analysis of the fatty acid content is not available at present, preliminary results show that the fatty acid content is less in treated samples. The fatty acid deficiency leads to damage to the membranes, and thus to hindrance in the structural basis of the development of a normal pigment system as revealed by the fluorescence spectra and the pigment analysis discussed above.

Effect of pyridazinone herbicides on the greening process

The herbicide treatment does not influence the greening as much does cerulenin treatment. Except in the case of SAN 9785 treatment, the greening of treated samples was almost as fast as that of the control (Fig. 6.A); the F687 band can be observed in all samples. The greening of the control leaves is completed in about 2 days, but the

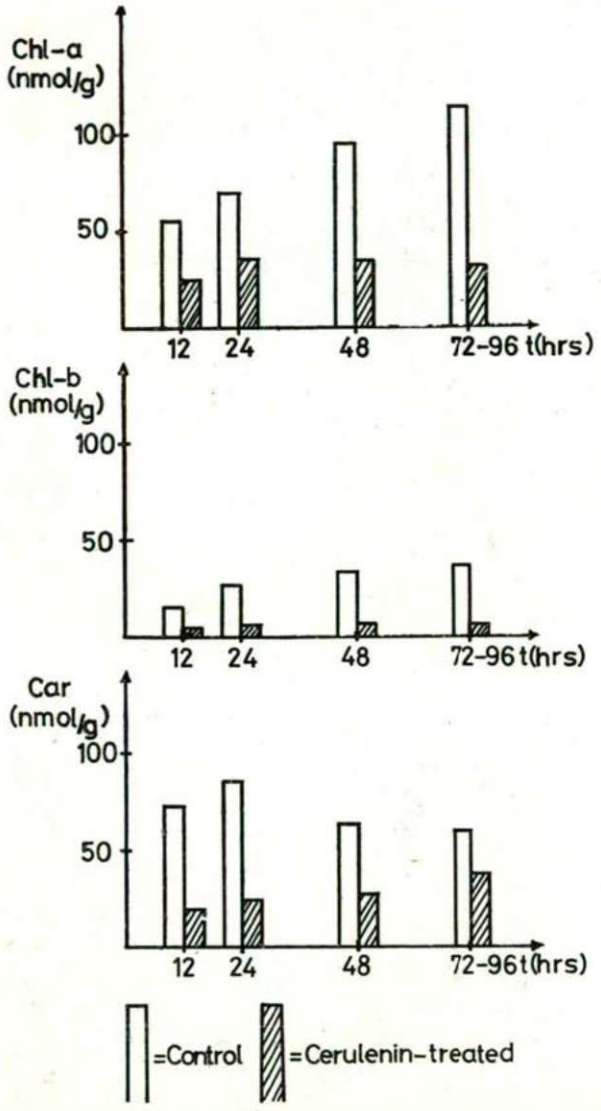

Fig. 3. Pigment content of control and cerulenin-treated barley leaves at several stages of greening measured and calculated on the basis of absorption spectra of pigment extracts.

accumulation and organization of chlorophylls is slower in treated leaves (Fig. 6.B). After 3—4 days of greening the spectra of SAN 6706—and SAN 9789-treated leaves practically coincide, with bands around 738 and 687 nm. However, the structure of the latter band (seen in the control) cannot be observed in treated samples (Fig. 6.C). These fluorescence spectra are reminiscent of those in Fig. 2.C. Even the presence of the difference spectrum band at 725 nm is seen (Fig. 7). The treatment with SAN

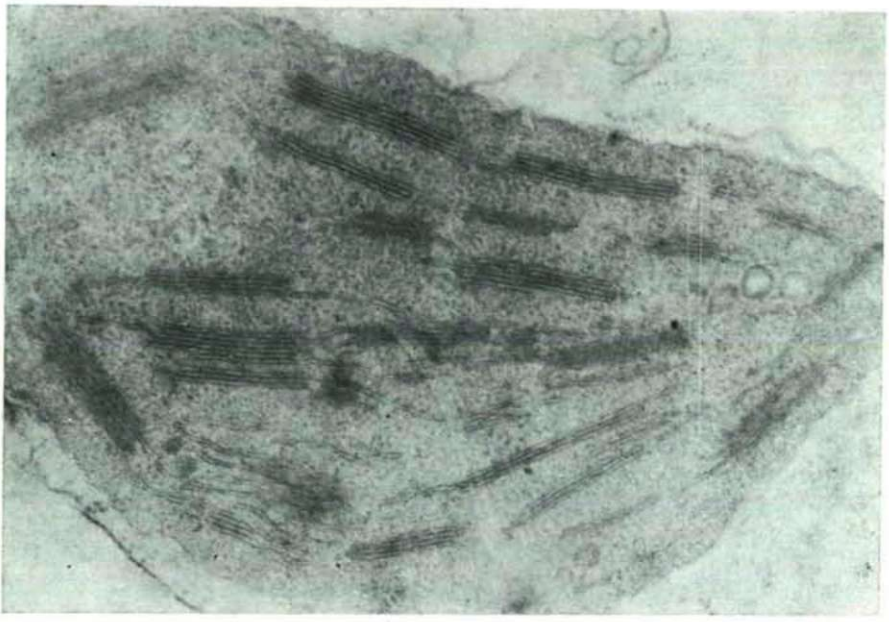

Fig. 4. Electron micrograph of untreated barley chloroplast (magnification 30.000).

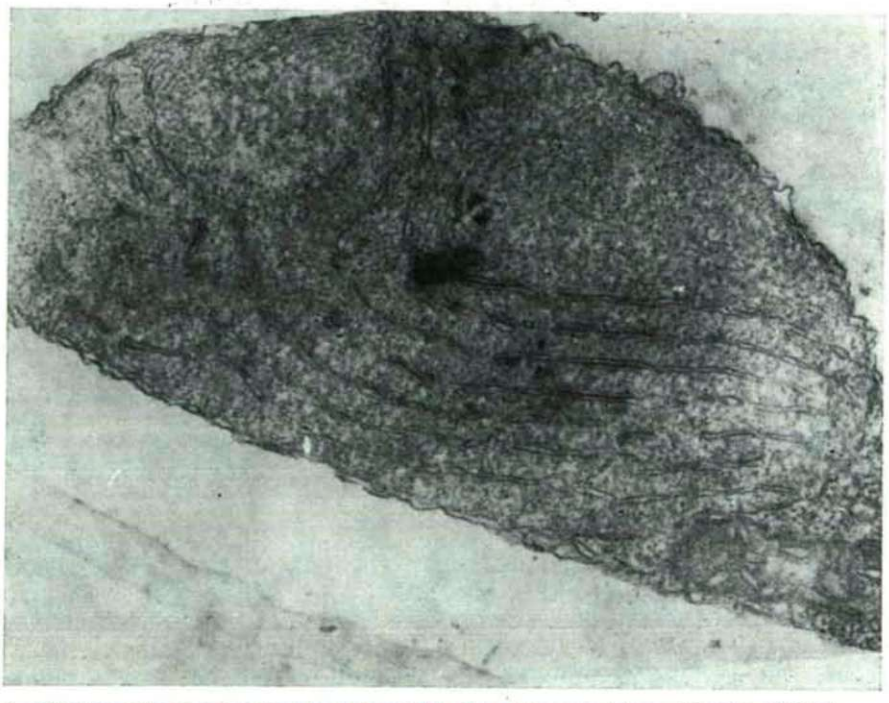

Fig. 5. Electron micrograph of cerulenin-treated barley chloroplast (magnification 30.000).

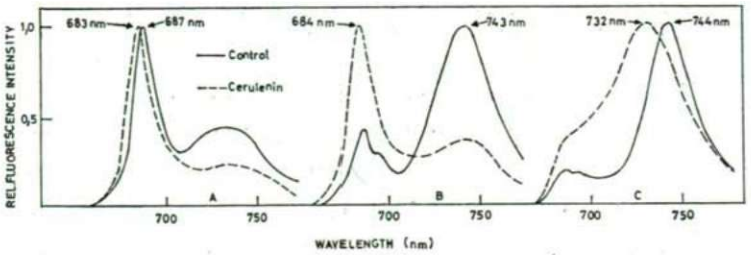

Fig. 6. Fluorescence spectra of control and SAN-treated barley leaves after 12 hours (A), 48 hours (B) and 96 hours (C) of illumination measured at −196 °C.

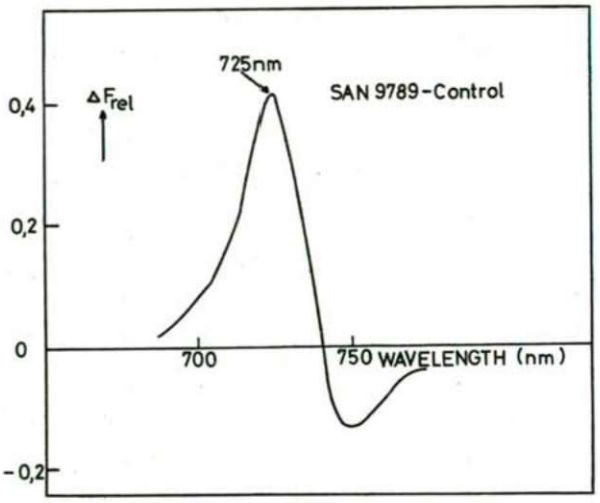

Fig. 7. The fluorescence difference spectrum of SAN 9789-control after 96 hours of illumination calculated on the basis of fluorescence spectra.

9785 leads to a very small difference in the fluorescence spectra of treated and control leaves in the final stage of greening.

Table 2 contains the results of pigment analysis. The pigment content shows great differences in treated samples as compared to the control after 3 days of greening: the absolute amounts are much less in all cases: 40—80% chlorophyll-a, 30—50% chlorophyll-b and 50—80% carotenoid are present in treated samples. The ratios chlorophyll-a to -b and chlorophylls to carotenoids are different for different herbicides; in general, the relative amount of chlorophyll-a to -b is higher in treated samples. In the case of SAN 9785 the ratio of chlorophylls to carotenoids is nearly 1, due to the high inhibition of the accumulation of chlorophylls and the very low influence of SAN 9785 on the accumulation of carotenoids. As regards the development of this situation, Table 2 shows data for the greening process from 12 to 72 hours of greening.

The effects of these herbicides on the ultrastructure of the chloroplast are simi-

Table 1. Values of chl-a/chl-b and chl-s/ carotenoids ratios of control (c) and cerulenin-treated (cer) barley leaves at several stages of greening.

pigment	t (hrs)	Control	SAN 6706		SAN 9789		SAN 9785	
		n MOL/G	n MOL/G	%	n MOL/G	%	n MOL/G	%
Chl-a	12	53.6	43.3	80.8	42.4	79.0	24.3	45.3
	24	69.3	105.8	152.7	99.8	143.9	50.1	72.3
	48	90.4	86.6	95.7	88.6	98.0	47.5	52.6
	72	111.8	68.1	60.9	87.7	78.4	43.2	38.6
Chl-b	12	13.9	9.7	70.0	7.8	56.3	6.7	48.3
	24	26.5	16.9	63.6	18.6	70.0	9.1	34.3
	48	31.9	18.6	51.8	18.7	58.6	11.7	32.8
	72	35.8	16.5	46.1	17.8	49.7	10.9	30.4
Car	12	71.8	46.4	64.7	37.6	52.4	37.2	51.9
	24	84.1	49.2	58.4	54.5	64.8	52.0	61.8
	48	61.5	46.7	75.9	38.1	61.9	46.5	75.5
	72	59.2	35.4	59.8	27.3	46.1	49.2	83.1
$\frac{\text{Chl-a}}{\text{Chl-b}}$	12	3.8	4.4		5.4		3.6	
	24	2.6	6.3		5.4		5.5	
	48	2.8	4.7		4.8		4.1	
	72	3.1	4.1		5.0		4.0	
$\frac{\text{Chl}-a+b}{\text{Car}}$	12	0.9	1.1		1.3		0.8	
	24	1.1	2.5		2.2		1.1	
	48	2.1	2.3		2.8		1.3	
	72	2.4	2.4		3.9		1.1	

Table 2. Pigment content and ratios of control and SAN-treated barley leaves at several stages of greening measured and calculated on the basis of absorption spectra of pigment extracts. The values of control were chosen to be the basis of comparison in each case.

t(hrs)	12		24		48		72—96	
	C	Cer	C	Cer	C	Cer	C	Cer
Chl-a/Chl-b	3.8	8.0	2.6	6.7	2.8	5.3	3.1	5.0
$\frac{\text{Chl-a}+\text{Chl}-b}{\text{Car}}$	0.9	1.5	1.1	1.7	2.1	1.4	2.4	1.0

lar to those of cerulenin, but less expressed. The electron-micrographs of SAN-treated samples show both ordered and broken lamellae; two or (seldom) three are stacked, and in a comparatively short section only (Fig. 8). Compared to the control, both the amount and the quality of the membranes are different, indicating that these herbicides inhibit the formation of membrane constituents.

Fig. 8. Electron micrograph of SAN 9789-treated barley chloroplast (magnification 22.000).

From fluorescence spectroscopic evidence we can conclude that these herbicides hardly influence the transformation of protochlorophyll (ide)s to the final chlorophylls, and (for a time) the accumulation of chlorophylls is also practically intact, but the organization of chlorophylls is inhibited. The electronmicrographs reveal that the formation of chloroplast membranes is damaged by herbicide treatment. It is not clear what the primary cause of the herbicide effect is: SAN 6706 and SAN 9789 are known to inhibit the biosynthesis of carotenoids, and according to our experiments the inhibition reaches even 50%, this (at least in part) may be responsible for the structural alterations in the membranes. No direct effect is known on chlorophyll biosynthesis. The defects in the organization of the photosynthetizing apparatus (lack of a normal pigment system with proper pigment forms, deficiency of the membrane structure resembling the defects caused by cerulenin-treatment, but less expressed), can be ascribed to similar, not fully understood reasons.

Acknowledgements. The authors express their thanks to the firm SANDOZ for the generous supply of herbicides SAN 9785, SAN 6706 and SAN 9789. Thanks are due to Mr. K. Gulya and the Institute of Biophysics, Biological Research Center of the Hungarian Academy of Sciences, for the micrographs and the use of the electron-microscope.

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PREPARATION AND SPECTROSCOPIC PROPERTIES OF AN ALBUMIN-CHLOROPHYLL-a COMPLEX

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Abstract

Albumin in phosphate buffer and chlorophyll-a in dioxane were mixed, dialysed and gel-filtered. A uniform, homogeneous system was separated. The absorption, fluorescence and excitation spectra show that a complex was formed: a non-stochiometric aggregate of albumin, chlorophyll-a and dioxan molecules. In this complex chlorophyll-a is attached to albumin in monomeric or dimeric (possibly higher aggregated) forms, with very loose energetic interaction, as revealed by the absence of intermolecular energy transfer from albumin to chlorophyll-a. The system does not seem a very suitable choice as a model for protein-pigment complexes.

Introduction

For a more detailed understanding of the primary processes of photosynthesis, it is necessary to know the environment of the pigment molecules taking part in hem. In recent years methods have been developed by means of which pigment, protein complexes can be isolated from photosynthetising membranes (THORNBER, 1975). Antenna pigment-protein complexes have molecular weights in the range 20.000—30.000 dalton and contain only a few pigment molecules; their protein moieties consist chiefly of non-polar amino acids (KVEY-SVEY KAN and THORNBER, 1976).

It is of interest to examine artifical pigment-protein complexes, for their constituents are well known. Accordingly, from the changes observed as a result of variations in their compositions, conclusions can be drawn regarding their interactions. From a study of the interaction of chlorophyll aggregates and proteins, SEMICHAEVSKI et al. established that human serum albumin takes part in a hydrophobic interaction with chlorophyll and enhances the photochemical activity of aqueous chlorophyll (SEMICHAEVSKI et al., 1971). GILLER et al. (1970, 1972) prepared a water-soluble pigment-protein-lipid complex from milk and a chlorophyll solution in acetone; they examined this with spectroscopic methods and attempted to draw conclusions on the bonding state of the pigment from treatment with organic solvents. The photochemical activities of the chlorophyll in analogous complexes were determined by DIAMANT and AGHION (1973).

The aim of the present work is to prepare a complex containing protein and chlorophyll, and to examine this spectroscopically. Bovine serum albumin was selected as protein, for this is well known both spectroscopically (KONEV, 1967) and as regards the binding sites of the pigment (KARUSH, 1950). The chlorophyll was dis-

persed in aqueous albumin solution with the aid of dioxan, as this is miscible with water and causes only reversible changes in proteins, while at the same time it can be removed by dialysis (SINGER, 1962). A further advantage is that it absorbs only at wavelengths shorter than 270 nm.

Materials and Methods

Albumin (crystallized, product of BDH Chemicals Ltd) was used without preliminary purification. Chlorophyll was prepared from spinach according to STRAIN et al., (1963), and was stored in diethyl-ether at ca. −10 °C. The concentration of both the chlorophyll- a and the protein in the solutions was 5.10^{-6} M. The protein was dissolved in 0.15 M phosphate buffer of pH 7.4. Chlorophyll-a in dioxan was mixed with the protein solution for 15 minutes with a magnetic stirrer on a 40 °C water-bath (ratio of protein solution to chlorophyll-a solution 64:1 by volume). (The necessary amount of chlorophyll-a was obtained by evaporation of a diethyl-ether solution to dryness, and the residue was dissolved in dioxan.) After stirring, the solution was dialysed at 4 °C for 48 hr in the dark against a 20-fold volume of phosphate buffer of pH 7.4 to remove the dioxan from the medium. The external buffer was exchanged at 10-hr intervals. The dialysing membrane was permeable for substances with molecular weights up to 10.000 dalton. Similar methods were used to prepare a buffered solution not containing albumin, and also the same buffered solution not containing chlorophyll-a. The chlorophyll content of dioxan removed by dialysis was 1—5% of chlorophyll content of the solution before dialysis.

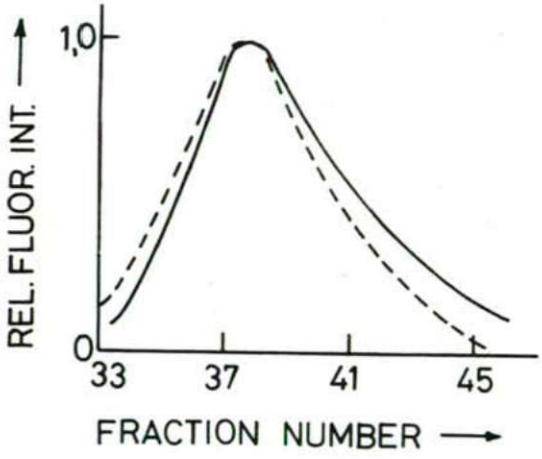

Fig. 1. Relative fluorescence intensities of gel-filtered fractions of dialysed albumin-chlorophyll-a solutions excited at 280 nm, observed at 330 nm (albumin fluorescence, solid line), and excited at 435 nm, observed at 685 nm (chlorophyll-a fluorescence, broken line).

The homogeneity of the solutions was checked by gel-filtration on Sephadex G-100. The solution transferred to the filtration column was washed through with phosphate buffer. One ml fractions of the eluate were taken and the intensities of their fluorescence were measured at 300 nm (albumin fluorescence) and 685 nm (chlorophyll-a fluorescence) with excitation at 280 nm and 435 nm, respectively. The relative fluorescence intensity is shown as a function of the fraction number in Fig. 1. The protein (continuous line) and chlorophyll-a (dashed line) fluorescence curves practically coincide; this indicates that the albumin and the chlorophyll-a pass through the filter together.

The filtered solutions were stored at 4 °C in the dark for about 24 hr. Next the absorption spectra were recorded at room temperature with an SP-300 Unicam spectrophotometer, and the fluorescence and excitation spectra were recorded at room temperature with an MPF 44A Perkin-Elmer spectrofluorimeter.

Results and Discussion

Absorption Spectra

Figure 2 shows the absorption spectra of chlorophyll-a in dioxan, and dioxan dispersion in buffer solution before and after dialysis in terms of $k(\lambda)$, the absorption coefficient $(k(\lambda)=E(\lambda)/l)$; and l are the extinction and layer thickness, respectively. In the aqueous dispersion before dialysis the red absorption band of chlorophyll-a is shifted about 20 nm towards longer wavelength, and the half-bandwidth is increased from 20 to 24 nm, this indicates a solvent effect and the formation of chlorophyll-a aggregates. If this dispersion is dialysed the maximum is at around

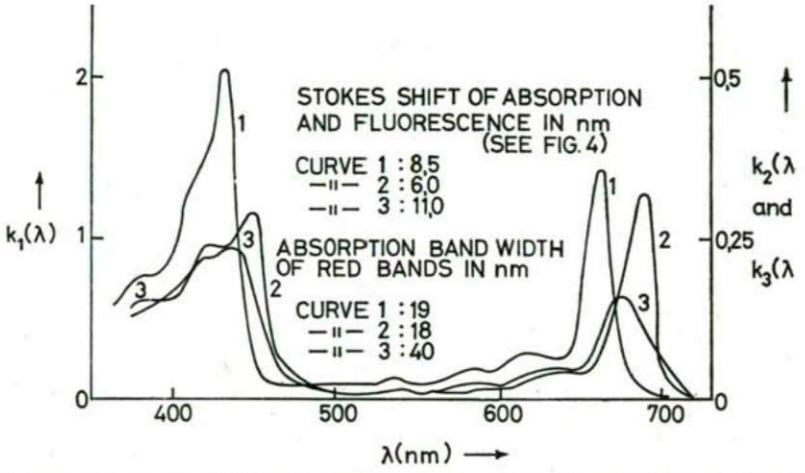

Fig. 2. Absorption spectra of 5.10^{-6}M chlorophyll-a in dioxan (1), $k_1(\lambda)$-left scale, in dioxan and phosphate buffer before (2) and after dialysis (3), $k_2(\lambda)$ and $k_3(\lambda)$-right scale.

675 nm, the half-bandwidth is increased to about 40 nm, and the intensity of absorption is considerably decreased. Since the dialysing membrane is not permeable to species with molecular weights greater than 10,000 dalton, the absorption changes suggest that large chlorophyll-a aggregates are also present in the system. Dialysis removes the dioxan and this gives rise to enhancement of the aggregation. The absorptions of solutions containing both albumin and chlorophyll-a are almost the same before and after dialysis (Fig. 3). The halfwidths of the red band before and after dialysis are 25 and 24 nm, respectively, and the positions of the maxima 682 and 683 nm, respectively. The very small change in the red band can be interpreted in that the presence of the albumin stabilizes monomeric and possibly dimeric chlorophyll-a, but not larger aggregates (SHERMAN, 1963).

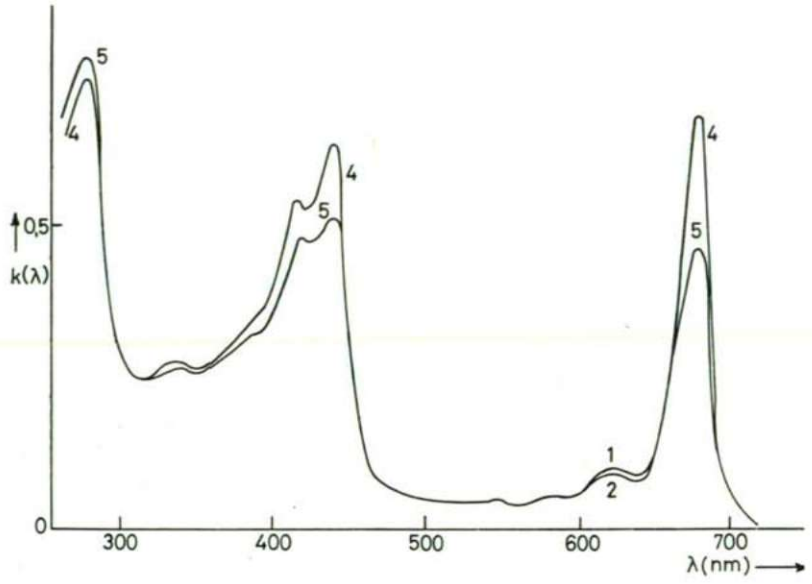

Fig. 3. Absorption spectra of mixture of 5.10^{-6}M chlorophyll in dioxan and 5.10^{-5}M albumin in phosphate buffer before (4) and after dialysis (5).

Fluorescence spectra

For the fluorescence spectra similarly as for the absorption spectra appreciable changes can be observed between the fluorescence spectra of a chlorophyll-a solution in dioxan and buffer before and after dialysis (Fig. 4) excited at 435 nm. The fluorescence spectra of solutions containing albumin and chlorophyll-a together are practically the same before and after dialysis (Fig. 5). In both cases, prior to dialysis the band with maximum at 688 nm displays the highest intensity; indeed, in the system not containing albumin, virtually only this band is present. (Fig. 4, curve 2; Fig. 5, curves 4 and 5). The quantum yield of chlorophyll fluorescence in the solution containing water too, is about 250 times less than that for chlorophyll dissolved in pure dioxan.

The Stokes-shifts of the maxima of the absorption and fluorescence spectra of systems containing protein are not changed after dialysis. This permits the conclusion that the interaction between the chlorophyll molecules is not changed either. Thus, the protein acts as a stabilizer of the structure of the chlorophyll-a aggregates.

The protein fiuorescence spectra similarly support the assumption that dioxan still remains in the system after dialysis, for this is related with the fact that fluorescence spectra of protein solutions containing dioxan are broadened towards shorter waves (Fig. 5).

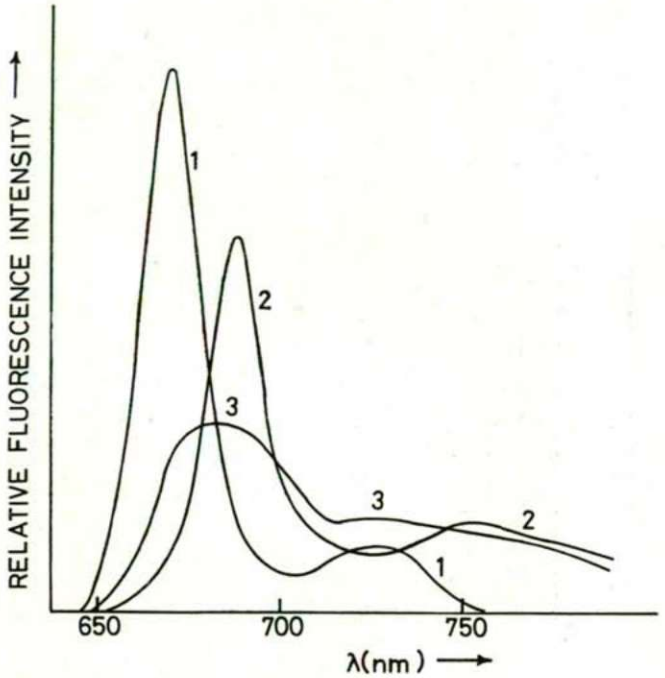

Fig. 4. Fluorescence spectra of 5.10^{-6}M chlorophyll-a solutions in dioxan (1), in dioxan and buffer mixture before (2) and after dialysis (3).

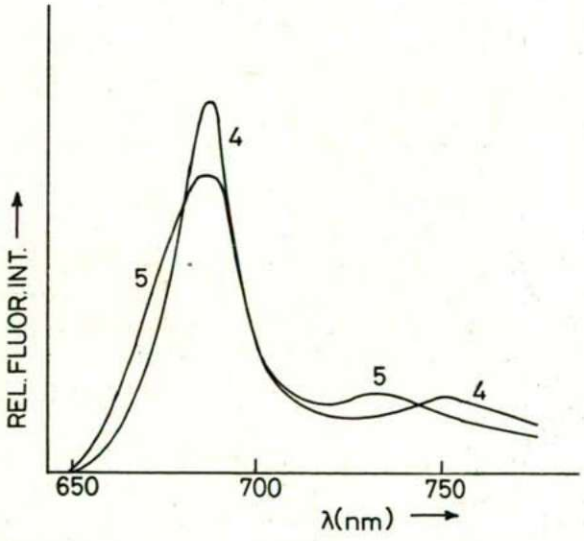

Fig. 5. Fluorescence spectra of a mixture of 5.10^{-6}M albumin buffer solution and chlorophyll-a dioxan solution before (4) and after dialysis (5).

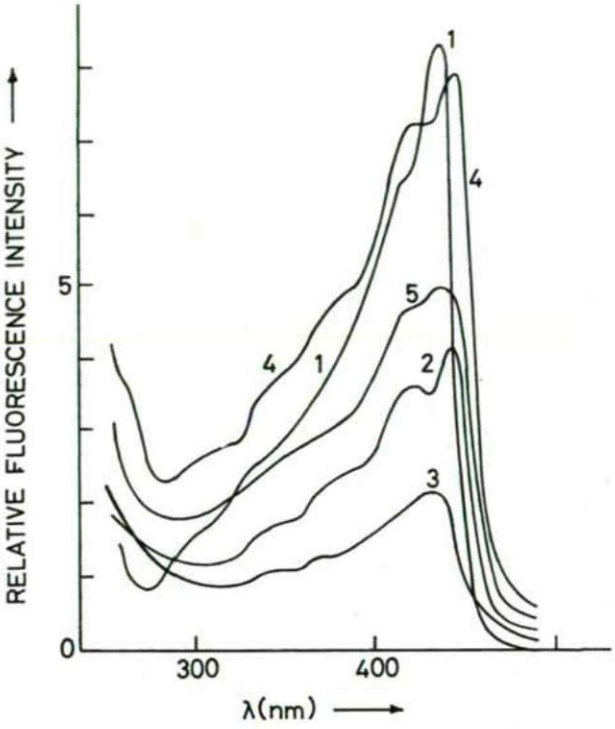

Fig. 6. Fluorescence excitation spectra of 5.10^{-6}M chlorophyll-a in dioxan with 670 nm observation in dioxan and phosphate buffer mixture before (2) and after (3) dialysis with 690 nm observation in mixture of 5.10^{-6}M albumin in phosphate buffer and 5.10^{-6}M chlorophyll-a in dioxan before (4) and after dialysis (5) with 687 nm observation.

Fluorescence excitation spectra

The fluorescence excitation spectra (Fig. 6) coincide with the absorption spectra (Fig. 2—3) with the exception of the ultraviolet region. In solutions containing albumin, the 280 nm band characteristic of the absorption (see Fig. 3) does not appear, which shows, that the electron excitation energy is not transferred from the chlorophyll-a, i.e. these compounds are not in an energy-transfer relation. It may be assumed that the albumin interacts close with the chlorophyll aggregates in dioxan, as if it were their "carrier".

To summerize, it may be stated that with the above method it is possible to prepare an albumin-chlorophyll complex but only in very low yield. The majority of the chlorophyll-a added to the aqueous buffer forms aggregates with the dioxan before it can couple with the albumin; these dioxan-chlorophyll aggregates are washed out of the system during dialysis. It is however not possible to remove the dioxane completely from the chlorophyll-albumin complex. Since the result is low yield of a non-stoichiometric albumin-chlorophyll complex which, in addition to chlorophyll

monomers also contains dimers and slightly larger aggregates, and even dioxane molecules, the complex is not an appropriate choice as a model for photosynthetic pigment-protein complexes.

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THE EFFECT OF ALTERNATING PERIODS OF LIGHT AND DARKNESS ON THE TISSUE OF PHASEOLUS VULGARIS L.

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Abstract

A study has been made on bean plants (*Phaseolus vulgaris* L cv. Harvester) grown under three different treatments wirh periods of 16—8, 1—0.5, and 8—4 hours of light and darkness resp., light intensity 35 Watt/m², temperature 22 ± 1 °C, and relative humidity 65 ± 5%, were the same in all the three treatment.

As compared to the control 16—8 hours it was found that dry weight was the greatest for 5 week plants under a cycle of 8—4 hours of light and darkness.

Primordia leaves grown under 1—0.5 hour rhythm show a decrease in thickness as compared to the 8—4 hours and 16—8 hours of light and darkness.

There was a slight difference in the stomata number of upper leaf surface for plants grown under the treatments, while for the lower stomata number there was found an increase in the rhythm of 1—0.5 hour as compared to the 8—4 hours and 16—8 hours.

The growth of vascular bundles of stem and root was the best under 16—8, and 8—4 hours, and the poorest growth took place under 1—0.5 hours.

Introduction

Light exerts a considerable effect on the growth and development of plants. It is well-known, e.g., that the growth of the leaf, the elongation of the stem are generally stimulated by light.

The strength of illumination, apart from its effect on the organic matter production, has an effect on growth and development, as well. As a result of the low strength of illumination, the stem grows longer, becomes thinner, the leaves are smaller, the lamina of leaves are thinner.

The quality of light and the distribution of spectral energy has also an influence on the morphological properties and the tissue structure (HORVÁTH, 1965). It is for example, demonstrated that growth and leaf surface are increased under the influence of the red but particularly the blue-red spectral ranges.

The occurrence of light and dark cycles of a short period on certain plants exerts a considerable effect on the morphology and the accumulation of dry-matter. It was found by several investigators that the very short alternate periods of light and darkness have pronounced inhibitory effect on growth and development. The effect of light and dark cycles between 1-min. and 12-hours was observed in Cucumber by PORTSMOUTH (1937) and in *Salvinia* by RAJAN et al. (1971), and it was found that plants subjected to 1-min. cycle were greatly reduced in height and over-all leaf area.

HORVÁTH and co-workers (1976, 1977) have found in *Phaseolus* and *Sinapis* grown in 4-hours' light and 2-hours' dark, the utilization of photosynthetic energy and dry weight was about 20% higher than the treatment of 16—8 hours light and darkness.

In the course of our investigations, we have dealt with the effect of alternating periods of light and darkness on the tissue structure of the leaf, stem and root.

Materials and Methods

Our experiments were carried out in the phytotron of the Botanical Garden of Attila József University, Szeged. HORVÁTH (1972). The used plants were *Phaseolus vulgaris* L., cv. Harvester grown in pots containing coarse sand and perlite. At the beginning of the experiment the 70% water capacity of sand was set on with KNOP's nutrient solution. The plants were watered daily with distilled water and once a week with KNOP's nutrient solution.

Three chambers were used in the experiment one of them is the control with a 16-hours' light and 8-hours' dark, and the other two supplied with a short rhythm of 1—0.5 and 8—4 hours of light and darkness, respectively, and the total daylength in both rhythms was 16-hours' light. In the three treatments light intensity was 35 Watt/m² (supplied with 40 W F 29 fluorescent tubes)., temperature was 22 ± 1 °C, and relative humidity was maintained between 65 ± 5%.

The investigation was repeated on the three occasions, in each case 18 plants were elaborated. The elaboration took place 2, 3, 4, and 5 weeks after sowing. Fresh materials from each plant were placed in an electric oven in 105 °C and then dried 70 °C until it attained the constant weight.

For anatomical study, the primordia, the 2nd internodium of stem and about 2 cm from the apices of roots were collected and fixed in 70% alcohol. The epidermis and cross-sections were prepared from the middle part of the leaf. Several sections were made by hand and others by hand microtome, after being cleaned they were stained with haematoxylin and mounted in glycerine jelly by customary methods.

The histological study includes the following calculations:

a) stomata and epidermis per sq. mm. for both upper and lower surfaces, with the help of a lanometer.

b) leaf thickness, ratio between palisade and spongy parenchyma, cell size, and the number of layers.

c) proportion of cortex, phloem, xylem, and pith to each other and to the whole tissue structure of both stem and root.

We have calculated the percentage on the cross-sections on the basis of determining the area of the single tissue regions.

The mathematical and statistical analysis of the data was obtained by using the methods of significance and correlation. (SVÁB, 1973).

Results and Discussion

Alternation of cycles of light and darkness has a marked influence on the accumulation of dry weight and the tissue structure of the leaves, stem, and roots. In the evaluation of our results we have considered the following data:

Total dry-matter

As compared with control 16—8 hours of light and darkness it was found that the plants of 2-weeks grown under the treatment of 8—4 hours show a slight increase for dry matter production of about 8—10%, while those grown under treatment of 1—0.5 hour decreased it and the decrease was about 8—10%. Plants of 3-weeks grown under the rhythm of 8—4 hours exhibit no difference in comparison with the control.

At weeks 3, 4, and 5 the dry weight per plant in 1—0.5 rhythm was about 30% lower than in the control plants, while the one of 8—4 rhythm causes an increase only to 4 and 5 week plants, and the increasing was about 10% as compared to the control plants. Fig. 1.

Dry weight percentages of the organs

Plants of 2, 3, and 4 weeks grown under the three treatments show no difference in dry weight percentages for leaves, stem, and roots, but in case of 5th week plants the percentage ratio of leaves at the rhythm of 1—0.5 hour was about 47% as compared with 53% of the control, although the percentage ratio of the stem grown at 1—0.5 hour and 8—4 hour rhythm was about 25%, whereas the control presented 19%. The roots grown at 1—0.5 hour show a higher percentage about 28% than that of the control which was 23%.

Epidermis

In the three treatments 16—8, 1—0.5, and 8—4 hours no difference was found in the epidermal cells of upper leaf suface of plants at the age of 2, 3, and 4 weeks, while those of 5 weeks old grown at 8—4 hours show only a slight decrease of about 10% as compared with control 16—8 hours.

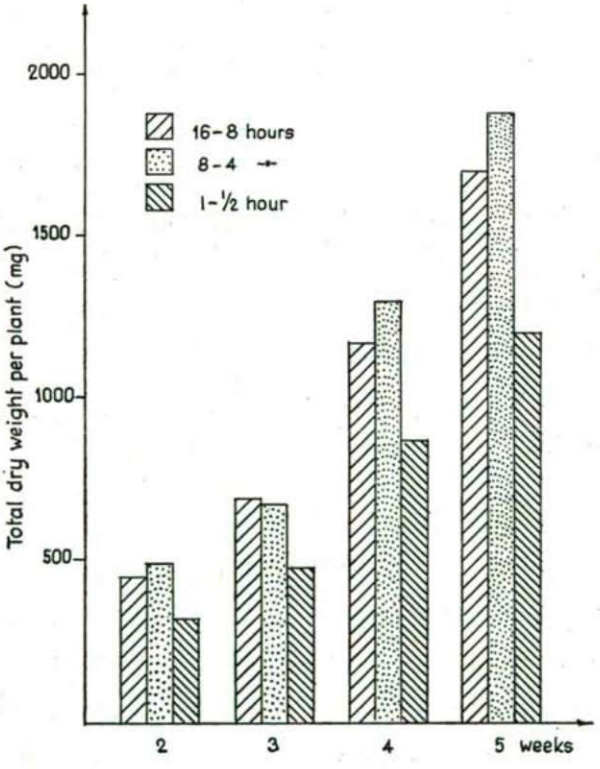

Fig. 2

In case of lower epidermal cells, it was found that plants of 2 weeks old grown under the three treatments did not show any significant difference. At week 3 the epidermal cells of 8—4 rhythm plants show a decrease of about 10% as compared with the control plants, while those of 1—0.5 rhythm show a very slight increase. At week 4 rhythms of 1—0.5 and 8—4 hours causes a decrease in the epidermal cells of about 10% as compared with the control.

Stomata

As compared with the control 16—8 hours of light and darkness it was found that plants of 2 weeks old grown under the treatment of 8—4 show an increase in stomata number of the upper leaf surface of about 20%, while those of 1—0,5 hour rhythm show no difference. On the other hand, plants of 5 weeks old grown under the three treatments do not show any difference in stomata number of the upper leaf surface.

For the lower part of leaf surface, it was found for plants of 2 weeks old grown under the three treatments that the lower stomata numbers are equal. Plants of 4 weeks old grown at the rhythm of 1—0.5 and 8—4 hours exhibit a slight decrease as compared to the control 16—8.

Leaf thickness

As compared to the control 16—8 hours, plants of 3, 4, and 5 weeks grown under the rhythm of 1—0.5 hour show a marked decrease in primordia leaf thickness, while those of 8—4 hours exhibit only a slight increase.

Stem

During our histological investigation on the stem, we have taken into consideration the structure and the rate of participation of the following regions:

Cortex, phloem, xylem, and pith. It was found that plants grown under the rhythm of 1—0.5 hour show a slight decrease in the percentage ratio of cortex, xylem, and phloem, while those of 8—4 rhythm show no difference as compared to the control 16—8 hours of light and darkness.

Root

According to the results we found that the percentage ratio of the stele of plants grown at 16—8 rhythm is 15 percent, at 8—4 rhythm it is 12 percent, and at 1—0.5 rhythm it is 10 percent.

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Plate I

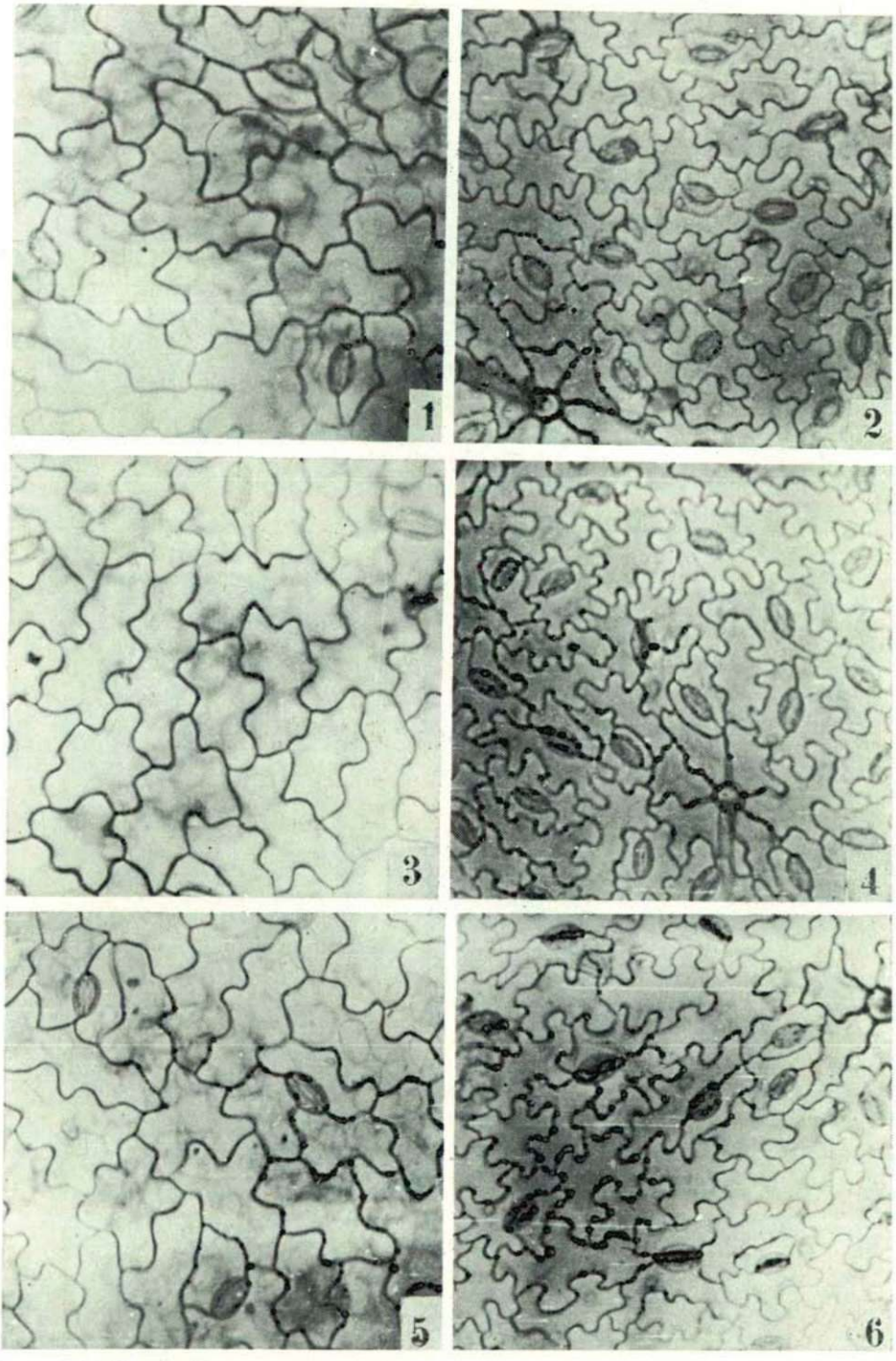

Fig. 1—6. Epidermis of upper and lower leaf surface of bean plants (*Phaseolus vulgaris* L.) — intensity of illumination 35 Watt/m². 1 and 2 upper and lower leaf surfaces grown under 16—8 hours of light and darkness.
3 and 4 upper and lower leaf surfaces grown at 8—4 hours. 5 and 6 upper and lower leaf surfaces grown under rhythm of 1—0.5 hour. (X 200)

Plate II

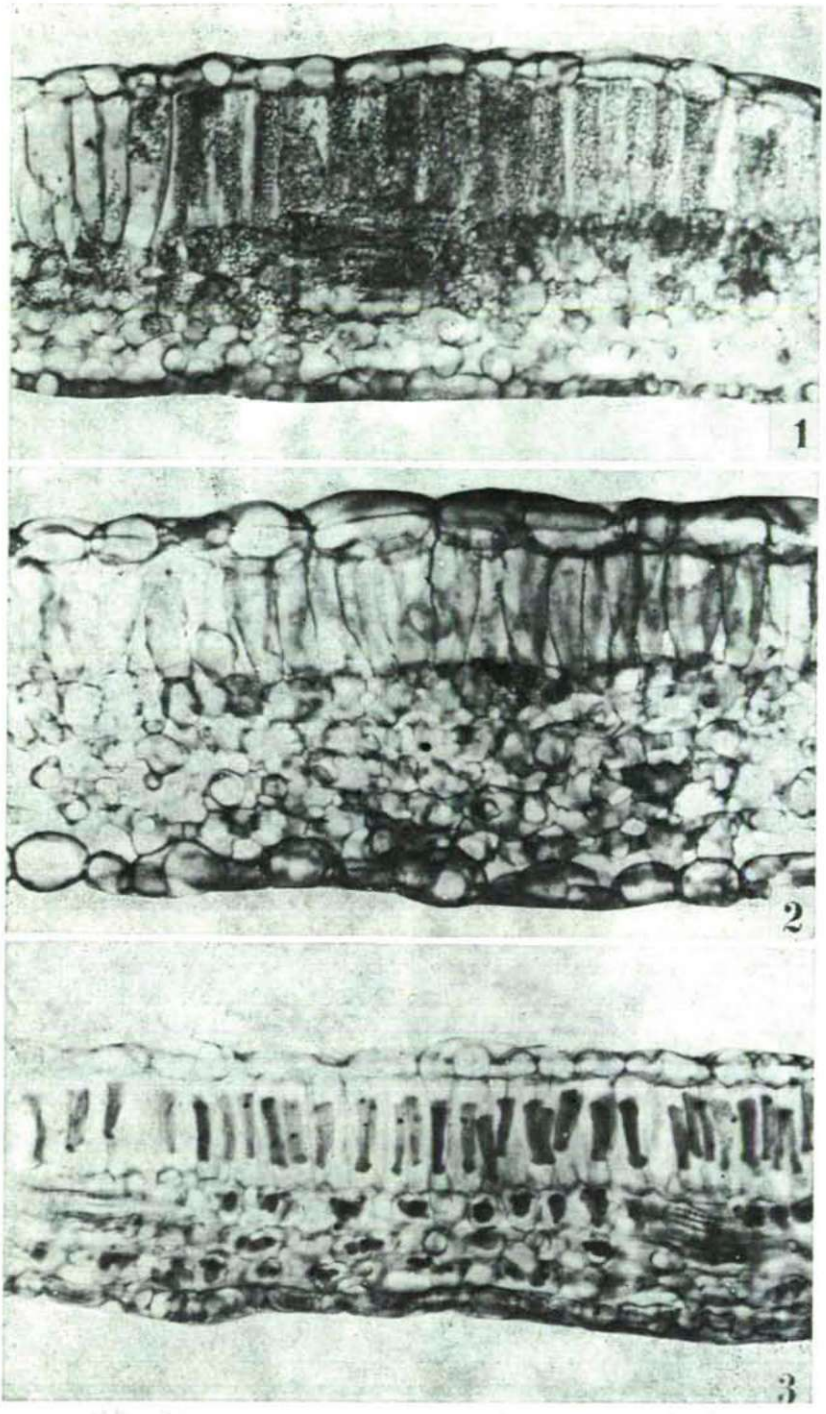

Fig. 1—3. Cross-sectional views of primordia leaves of bean plants (Phaseolus vulgaris L.) — intensity of illumination 35 Watt/m². 1/ 16—8 hours, 2/ 8—4 hours, 3/ 1—0.5 hour of light and darkness. (X 200)

Plate III

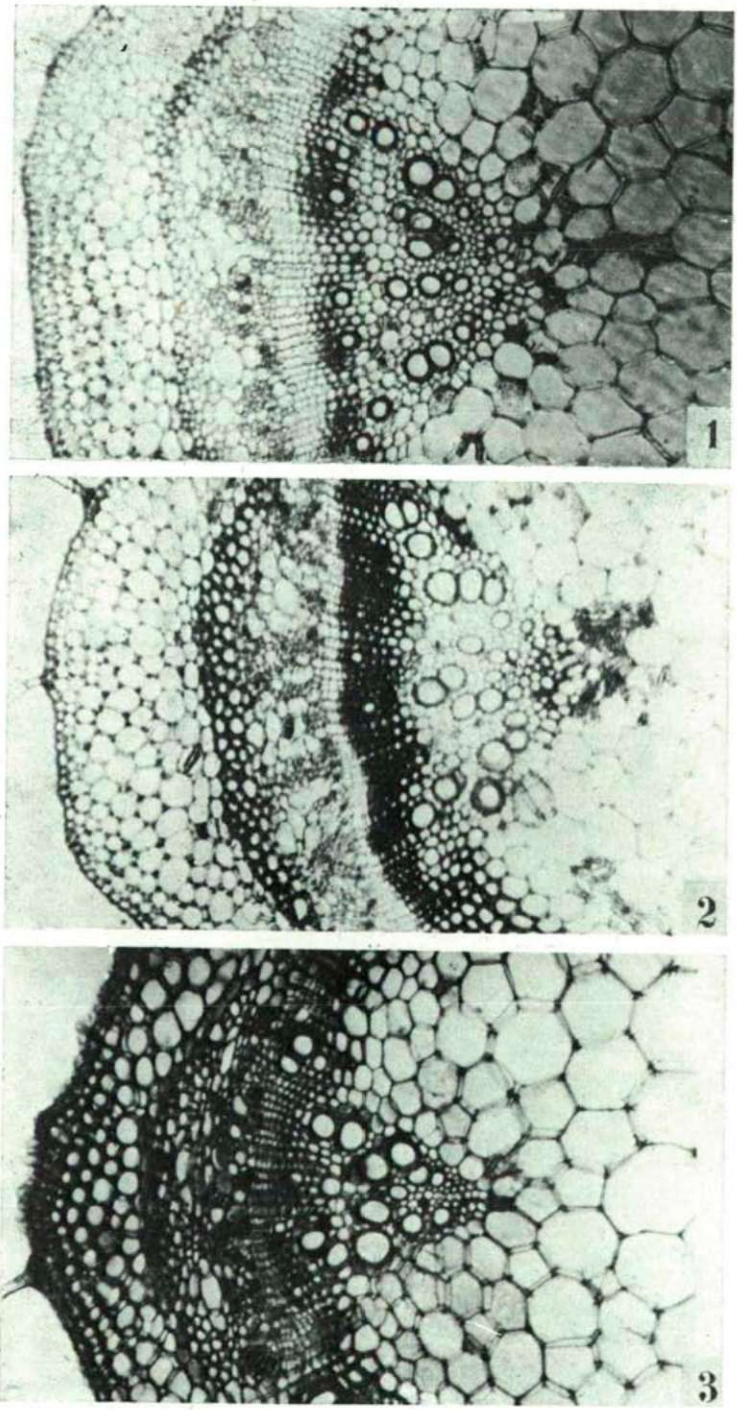

Fig. 1—3. Cross-sectional views of stem of bean plants *(Phaseolus vulgaris* L.*)* — intensity of illumination 35 Watt/m². 1/ 16—8 hours, 2/ 8—4 hours, 3/ 1—0.5 hour. (X 80)

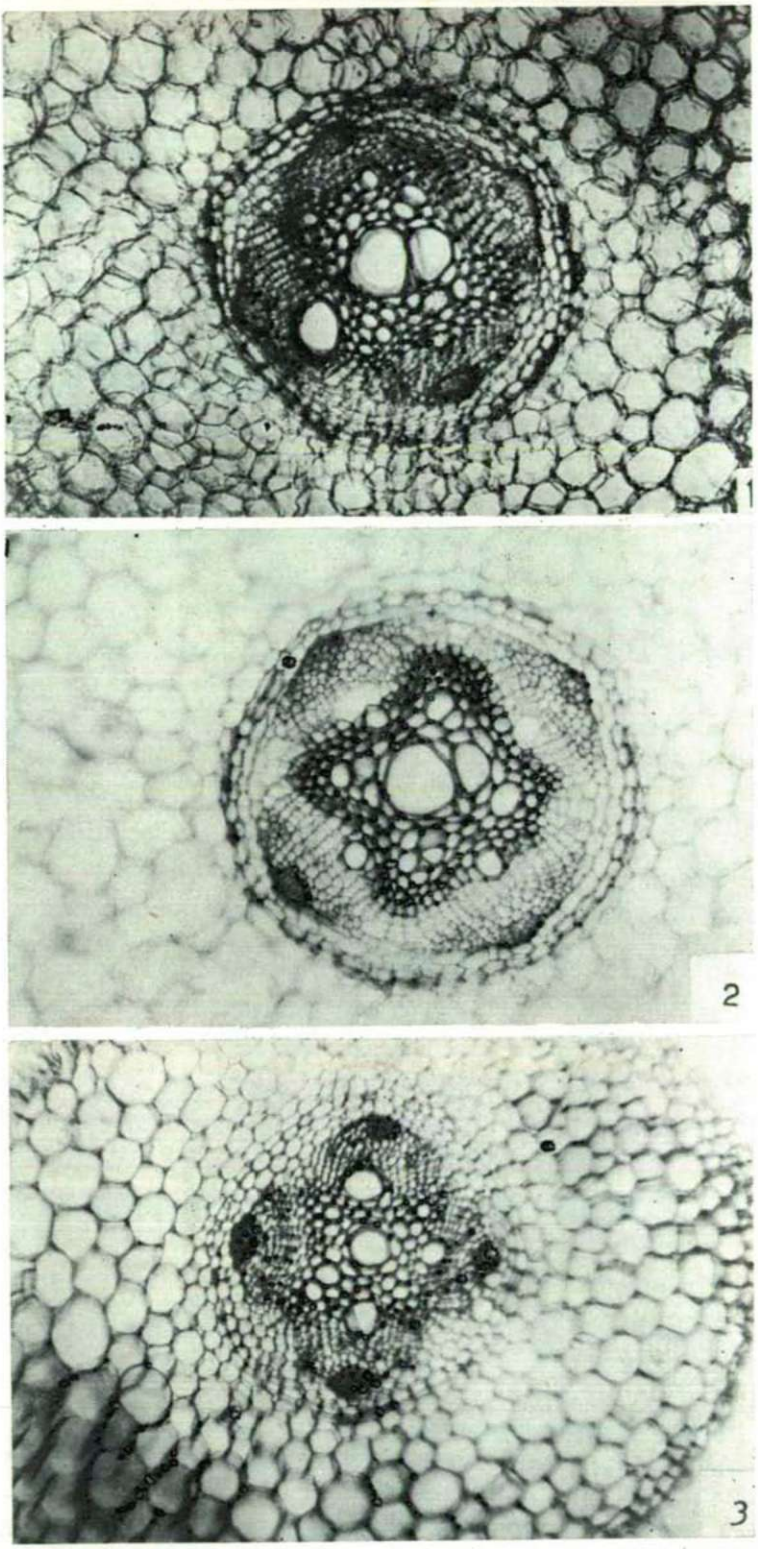

Fig. 1—3. Cross-sectional views of root of bean plants *(Phaseolus vulgaris* L.*)* — intensity of illumination 35 Watt/m². 1/ 16—8 hours, 2/ 8—4 hours, 3/ 1—0.5 hour. (X 100)

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BRYOPHYTE SPORES FROM HUNGARIAN EARLY CRETACEOUS ROCKS

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Abstract

From the spore-pollen assemblages of the Hungarian Lower and Middle Cretaceous sediments, 24 bryophyte-like spores are identified. Of these, the *Foraminisporis* and *Phaeocerosporites* species are placed into *Anthoceropsida*, the *Triporoletes, Couperisporites, Coptospora*, and *Aequitriradites* species into *Hepaticopsida*, the species of *Stereisporites* and *Cingutriletes* into Sphagnidae, the *Staplinisporites* and *Coronatispora* species into Bryidae. In the investigated sediments, the number of bryophyte spores is low, their stratigraphic importance is little, but in the Tés Formation (Middle Albian) these hornwort and liverwort spores are facies-marking.

Introduction

In the latter decade in Hungary, in the area of the Transdanubian Middle Mountains, several deep drilling have made. Investigating the spore-pollen assemblages of the Early Cretaceous rocks of these deep drillings, we can establish the existence of a high number of pteridophyte spores, in which the dominant part is taken by the spores of the ancient fern families of Pteropsida (Gleicheniaceae, Cyatheaceae, Schizaeaceae). The recent descendants of these are the floral elements of our tropics, subtropics. The question arises, what part is taken by the similarly spore-bearing bryophyte in the Hungarian Early Cretaceous flora, by which groups this phylum was represented. As moss megafossils, in situ spores are comparatively few, as well as the recent and fossil bryophyte spores are not too similar to each other, it is not easy to answer the question.

Previous works

The earliest geological record of a bryophyte is the fossil hepatic, *Hepaticites devonicus*, described by *Hueber* (1961), from the Upper Devonian sediments of North America. The megafossil records of fossil bryophytes were summarized by JOVET-AST (1967). He lists a total of 68 pre-Tertiary bryophytes (17 mosses and

9 liverworts from the Palaeozoic; 8 mosses and 34 liverworts in the Mesozoic.) He considers the Jurassic liverworts, in agreement with KRASILOV (1970), as representatives of Jungermanniales and Marchantiales. LUNDBLAD (1954) even found some spores in the fossils of the Jurassic. DETTMANN (1963) established, in the course of investigating the Lower Cretaceous sporomorphes, that the in situ spores of the fossil liverwort Naiadita lanceolata and the dispersed spores ranged into the formgenus Couperisporites were similar. The same similarity is established by him between the spores of the recent *Nothotylas, Phaeoceros* and the formgenus *Foraminisporis.*

KRUTZSCH (1963a) classified the Tertiary spores of the formgenera *Foraminisporis, Anthocerosporis, Saxosporis,* and *Rudolphisporis,* created by himself, into the Anthocerotaceae family. In another work, (KRUTZSCH, 1963b), within the Stereisporites formgenus, he created seven subformgenera and identified the Mesozoic and Tertiary forms, ranged into these, as representatives of the Sphagnaceae moss family. The expansion of this conception is to be seen in the work of DÖRING et al. (1966). It is made probable by KOTOVA (1968) that the spores of the Lower Cretaceous genera of turma Hilates, created by DETTMANN (1963) *(Coptospora, Aequitriradites, Cooksonites, Couperisporites)* are hepatic spores. She refers to UDAR's experiments (1964) with recent Hepaticae, where the creation of hilum can in a similar manner be observed as in case of the above-mentioned fossil spores. NAGY (1968) gives a summary of the moss spores of Neogene sediments in Hungary, by describing some new formgenera, formspecies. PLAYFORD (1971) ranged several Lower Cretaceous spore-forms among Bryophyta. He emphasized the priority of *Triporoletes* Mtched. 1960 over *Rouseisporites* POCOCK 1962. JARZEN (1979) described the spores of the Anthocerotaceae species and compared these with fossil Upper Cretaceous spores, as a result of which he ranged the latter forms into the extant *Phaeoceros* genus. Apart from the publications on fossil spores, as well as on the comparison of these with the recent equivalent a great help is given by the monographs on the recent moss spores, like e.g., the works of ERDTMAN (1957, 1965), BOROS et JÁRAI—KOMLÓDI (1975), in revealing the botanical relationship. The latter work is an excellent elaboration of the spores of the European mosses.

Systematic description

Phylum: Bryophyta

Classis: Hepaticopsida

Genus: Triporoletes (MTCHED. 1960) PLAYFORD 1971

1960 *Triporoletes Mtchedlishvili,* in METCHEDLISHVILI and SAMOILOVICH, pp. 127—128.
1962 *Rouseisporites* POCOCK, pp. 52—53.
1971 *Triporoletes* MTCHED. emend. PLAYFORD, pp. 551—553.

Remarks: PLAYFORD (1971) considered *Rouseisporites* POCOCK 1962 as a young synonym of the *Triporoletes* genus and, after emending the genus diagnosis, ranges the species earlier classed among *Rouseisporites,* among *Triporoletes.* SRIVASTAVA (1975) continued completing the above genus, putting several other genera in the

synonym list, not entirely without reason. As to the botanical relationship, — Playford —, refusing the angiospermoid theory of MTCHEDLISHVILI and SAMOILOVICH (1960), and based on the comparative work of DETTMANN (1963) in connection with the *Rouseisporites* species, establish a similarity with the spores of species, belonging to the Ricciaceae and Cleveaceae families of the recent hepatics.

Triporoletes radiatus (DETT. 1963) PLAYFORD 1971
(Plate I, Fig. 2.)

Remarks: The Hungarian specimens are identical in size but the zone, surrounding the spore-body, often tapers of tears off.

Triporoletes reticulatus (POCOCK 1962) PLAYFORD 1971
(Plate I, Fig. 3)

Remarks: This species shows a wide geographical and stratigraphical distribution. It occurs in the Hungarian Middle Cretaceous mainly in the fresh-water and shallow-water sediments, in a low number of specimens, thus e.g. in the coaly-clayey marl layers of the Tés Formation. (Middle Albian).

Triporoletes simplex (COOKSON et DETTMANN 1958) PLAYFORD 1971
(Plate I, Fig. 6)

Remarks: Generally there occur smaller specimens than those of the holotype in the Vértessomló Formation: it is a rare species.

Genus: Aequitriradites (DELC. et SPR. 1955) COOKS. et DETT. 1961

Remarks: DETTMANN (1963) established similarity, apart from the synonym list of the species belonging to *Aequitriradites,* between these spores and those of the recent Sphaerocarpaceae. KOTOVA (1968) published some good pictures of more than one species of the genus, where the hilum can be seen well. Evaluating UDAR's work (1964), carried out on extant hepatics, *Kotova* established that the hilum occuring in the extant hepatics, as well, is also an evidence for the Hepaticae-descent of the Cretaceous species classed into Hilates.

Aequitriradites spinulosus (COOKS. et DETT. 1958) COOKS. et DETT. 1961
(Plate I, Fig. 7)

Remarks: It occurs in the Hungarian Lower Cretaceous only sporadically. In the shallow-water sediments of the Tés Formation (Middle Albian), it is the characteristic species of the bryophyte vegetation.

Genus: Couperisporites POCOCK 1962
Couperisporites clavatoides (DEÁK 1964) n. comb.

(Plate I, Fig. 8.)

1964 *Nigrina clavatoides* DEÁK, p. 109—110.

Remarks: DEÁK (1964) described the species, frequently occuring in the marly sediments of Tés Formation, classified into the genus *Nigrina Maljawkina* 1949.

The hilum can be observed in several specimens, thus it is justified to place this species among *Couperisporites*. The sculpture elements, occurring in the zone, too, are bacula, clavae, but they are not at all similar to the spinose elements of *Couperisporites complexus* POCOCK 1962. DETTMANN (1963) published the fossil *Naiadita lanceolata*, regarding them as similar to those of the *Couperisporites* species.

Genus: Coptospora DETTMANN 1963
Coptospora sp.
(Plate I, Fig. 12)

Remarks: This spore has only occurred, so far, in two specimens together with other mainly liverwort spores, referring to a swamp-bog vegetation, in the sediments of Tés Formation.

Classis: Anthoceropsida

Familia: Anthocerotaceae

Anthoceropsida are represented by two formgenera in the Hungarian Middle Cretaceous: by the *Foraminisporis* W. KR. 1959 and *Phaeocerosporites* NAGY 1968 genera.

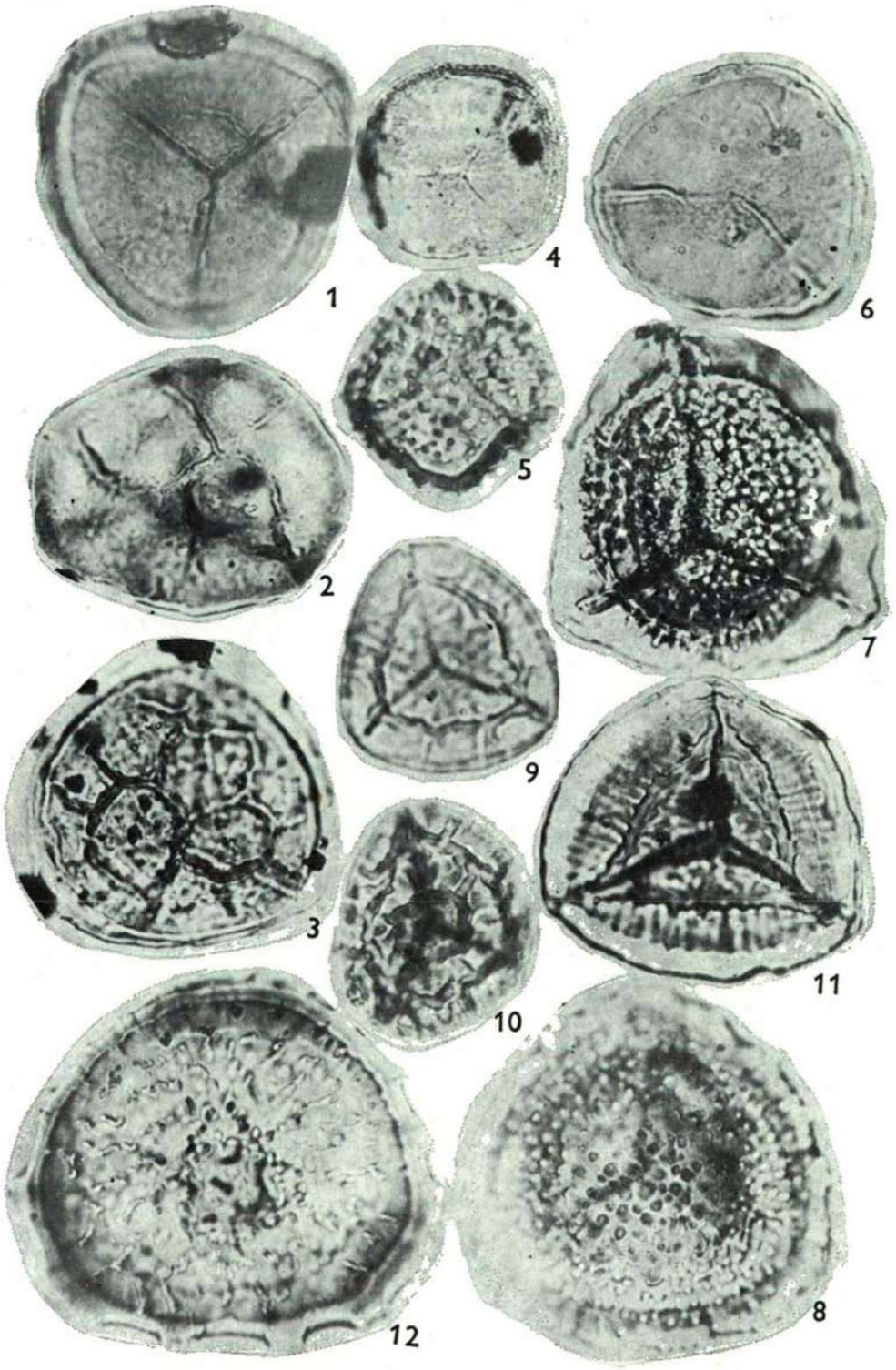
Genus: Foraminisporis W. KR. 1959

Remarks: KRUTZSCH (1963a) placed some of the Anthocerotaceae spores from Tertiary deposits into this genus. In the same year (1963), DETTMANN placed those of the Australian Lower Cretaceous spores were similar to the spores of the extant *Nothotylas breutelli* GOTTSCHE and *Phaeoceros bulbiculosus* (BROT.) PROSK. species, into the *Foraminisporis* W. KR. genus. *Foraminisporis* is also considered

Plate I

1. *Phaeocerosporites purus* (DEÁK 1964) n. comb. Tés, Tt-27. 50,5 m/1. P:32,5/108,8. Middle Albian
2. *Triporoletes radiatus* (DETTMANN 1963) PLAYFORD 1971 Süttő-3, 125/1. P:39,4/108,2. Lower Albian
3. *Triporoletes reticulatus* (POCOCK 1962) PLAYFORD 1971 Csehbánya, Cseh-5, 331,6/1. P:40/92,3. Middle Albian
4. *Foraminisporis dailyi* (COOKS. et DETT. 1958) DETTMANN 1963 Vértessomló. Vst-5, 48/2. P:35/98,4. Lower Albian
5. *Foraminisporis asymmetricus* (COOKS. et DETT. 1958) DETT. 1963 Olaszfalu, Pe-31, 131/2. P:34/101. Lower Cenomanian.
6. *Triporoletes simplex* (COOKS. et DETT. 1958) PLAYFORD 1971 Oroszlány. 0—1891, 509,5/1. P:40/100,7. Middle Albian
7. *Aequitriradites spinulosus* (COOKS. et DETT. 1958) COOKS. et DETT. 1961 Tés, Tt-27, 50,5/3. 113,5. Middle Albian
8. *Couperisporites clavatoides* (DEÁK 1964) n. comb. Tés, Tt-27, 32,2/1. P:29.3/108,2. Middle Albian
9. *Staplinisporites rotalis* DÖRING 1964 Sümeg, Süt-17, 322/1. P:43/95. Barremian
10. *Staplinisporites caminus* (BALME 1957) POCOCK 1962 Tatabánya, Ta-1495, 324/1. P:29,8/102. Lower Albian
11. *Coronatispora valdensis* (COUPER 1958) DETTMANN 1963) Szigetvár, Sz-3, 755/1. P:37,5/91. Albian
12. *Coptospora* sp. Olaszfalu, Ot-84, 109/1. P:39,4/107. Middle Albian

Plate I



by NORRIS (1967) as a bryophyte spore. JARZEN (1979) also described the spores of some extant Anthocerotaceae species. In a part of these spores, the foramen characteristic of *Foraminisporis* can be found. Others are rather similar to the *Phaeocerosporites described* by NAGY (1968).

Foraminisporis dailyi (COOKS. et DETT. 1958) DETT. 1963
(Plate I, Fig. 4)

Remarks: It has, together with *Foraminisporis asymmetricus,* a wide enough stratigraphic and geographic distribution in the Early Cretaceous. In the Hungarian sediments, it is a rare species.

Foraminisporis asymmetricus (COOKS. et DETT. 1958) DETT. 1963
(Plate I, Fig. 5)

Remarks: In the specimens investigated by me a great variety can be observed in the ornamentation of form, the size of foramen, and the shape. In the lower biozone of Vértessomló Formation, it is one of guide fossils.

Genus: Phaeocerosporites NAGY 1968

Remarks: This genus was created by NAGY (1968) for including the Anthocerotaceae spores having a distally rotund are but no foramen.

Phaeocerosporites purus (DEÁK 1964) n. comb.
(Plate I, Fig. 1)

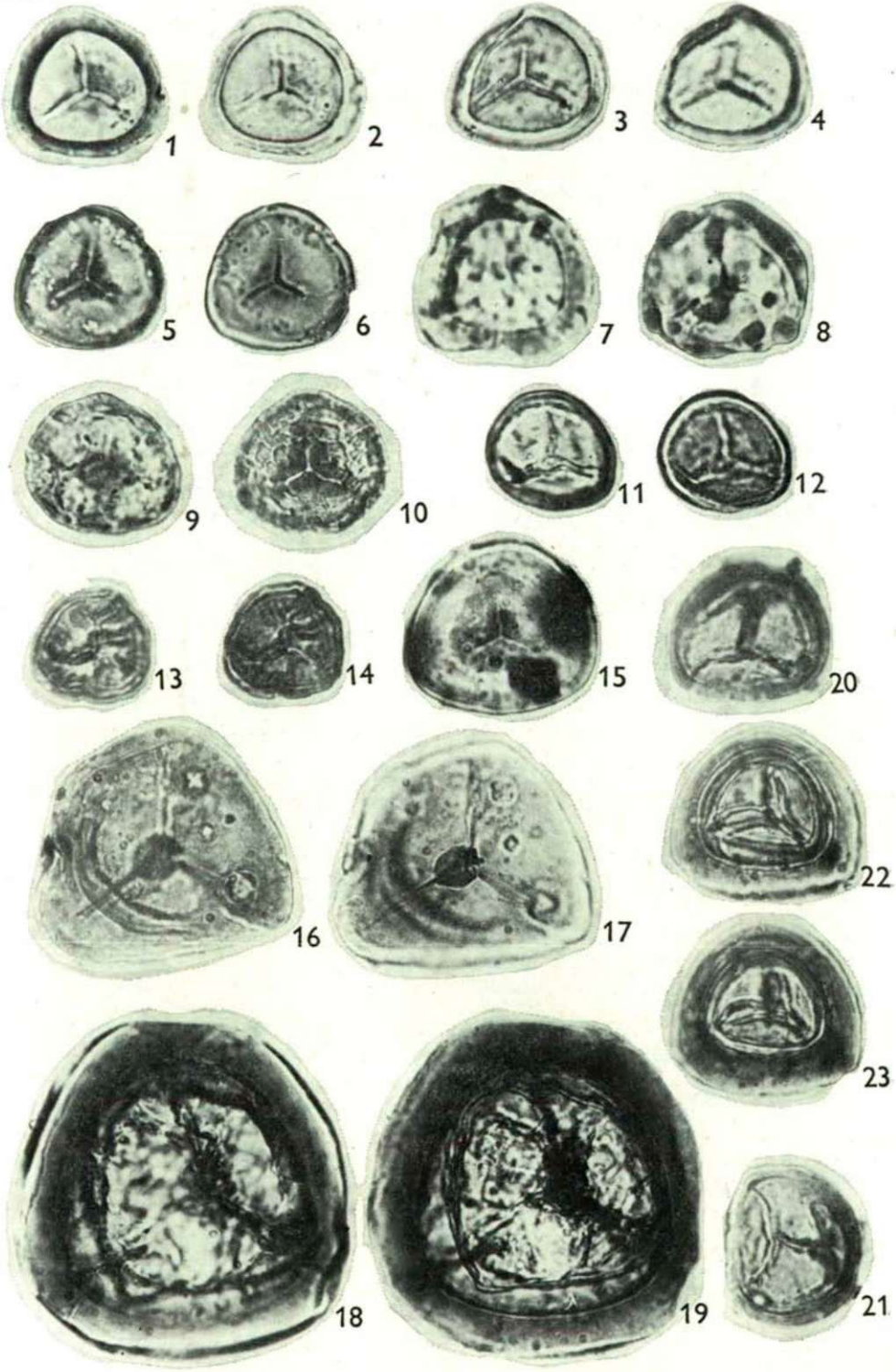
1964 *Purgatisporites purus* DEÁK, p. 109.

Remarks: The observed specimens have often a perisporium. This was emphasized by DEÁK (1964) when she created the *Purgatisporites* genus. We have been convinced by the study into several specimens and by the palaeo-ecological conditi-

Plate II

1—4. *Stereisporites psilatus* (ROSS 1949) PF. 1953 1,2=Balinka, Ba-237, 45/3. P:29/112,2. Upper Albian 3,4=Ba-237, 98/1. P:38,2/105,4. Upper Albian
5, 6. *Stereisporites antiquasporites* (WILSON et WEBSTER 1946) DETTMANN 1963 Tatabánya, Ta-1358, 369,5/1. P:28,4/97. Lower Albian
7. *Stereisporites aptiensis* (DEÁK 1964) n. comb. Süttő-3, 120/2. P:32,5/102,5. Lower Albian
8. *Stereisporites* cf. *grossus* TAKAHASHI 1964 Tatabánya, Ta-1495, 378/1. P:32,5/101,5. Lower Albian
9. *Stereisporites australis* (COOKSON 1953) n. comb. Ta-1495, 376/2. P:41/108,5. Lower Albian
10. *Stereisporites* sp_1. Ta-1329, 461/1. P:34,4/112,7. Neokomian
11, 12. *Stereisporites europeum* (BOLCH. 1953) CORNA 1972 Tés, Tt-27, 38,5/1. P:28,7/98. Middle Albian
13, 14. *Stereisporites apolaris* (REINH.) MIKI 1972 Sümeg, Süt-17, 245/1. P:39/98,1. Lower Aptian
15. *Stereisporites antiquasporites* (WILSON et WEBSTER 1946) Dettmann 1963 Vértessomló, Vst-5, 43,2/1. P:45,2/103.4. Lower Albian
16, 17. *Stereisporites* sp_2. Süttő-3, 108/2. P:33,3/98,4. Lower Albian
18, 19. *Cingutriletes* sp. Csehbánya, Cseh-5, 263/1. P: 34,3/102,2. Middle Albian
20, 21. *Cingutriletes levispeciosus* (PF. 1953) n. comb. Oroszlány, 0—1891, 578/1. P:41,7/104,9. Middle Albian
22, 23. *Cingutriletes clavus* (BALME 1957) DETT. 1963 Sur-1, 520/2. P:29/99,1. Middle Albian

Plate II



ons of the species that the spore in question is that of Anthocerotaceae, at the distal surface of which the rotund area is expressed enough. It is characteristic species of the swamp-bog vegetation of the Tés Formation.

Classis: Bryopsida

Subclassis: Sphagnidae

Familia: Sphagnaceae

Of the Cretaceous spores, the species of the *Stereisporites* TH. et PF. and *Cingutriletes* Pierce genera are classed into the family.

Genus: Stereisporites TH. et PF. 1953

Remarks: The *Stereisporites* genus was divided by KRUTZSCH (1963b) and DÖRING et al. (1966) into several subformgenera. In the "large genus", created in this way, a strong morphological heterogeneity may be observed. The botanical relationship of *Stereisporites* can be queried on this basis. We have been convinced by the investigations carried out on the recent Sphagnaceae spores (BOROS and JÁRAI—KOMLÓDI 1975; TALLIS, 1962; TERASME, 1955) that it is more justified to treat *Stereisporites* according to the genus conception created by THOMSON et PFLUG (1953) and used in the Lower Cretaceous palynology.

Stereisporites psilatus (ROSS 1949) PF. 1953
(Plate II, Figs. 1—4)

Stereisporites antiquasporites (WILSON et WEBSTER 1946) DETT. 1963
(Plate II, Figs. 5, 6, 15)

Stereisporites aptiensis (DEÁK 1964) n. comb.
(Plate II, Fig. 7)

1964 *Stenozonotriletes aptiensis* DEÁK, p. 111—112.

Remarks: In this form, the comparatively wide cingulum is less rounded in at two of the three corners. It is a rare species of the Tés Formation.

Stereisporites cf. *grossus* TAKAHASHI 1964
(Plate II, Fig. 8)

Stereisporites europeum (BOLCH. 1953) ČORNA 1972
(Plate II, Figs. 11—12)

Stereisporites australis (COOKSON 1953) n. comb.
(Plate II, Fig. 9)

1953 *Sphagnites australis* COOKSON, p. 464.

Stereisporites apolaris (REINH. 1961) MIKI 1972
(Plate II, Figs. 13, 14)

Stereisporites sp.$_1$
(Plate II, Fig. 10)

Stereisporites sp.$_2$
(Plate II. Figs. 16, 17)
Genus: Cingutriletes (PIERCE 1961) DETT. 1963

Remarks: KRUTZSCH (1963b) reduced *Cingutriletes*, created by PIERCE (1961), into one of the subformgenera of *Stereisporites*. DETTMANN (1963) emended the PIERCE's genus and listed its synonym, as well.

As to its botanical relationship, DETTMANN (1963), NORRIS (1967), and SINGH (1971) pronounced in favour of Sphagnaceae.

Cingutriletes clavus (BALME 1957) DETT. 1963
(Plate II, Figs. 22, 23)

Cingutriletes levispeciosus (PF. 1953) n. comb.
(Plate II, Figs. 20, 21)

Cingutriletes sp.
(Plate II, Figs. 18, 19)

Distribution: The above-mentioned *Stereisporites* and *Cingutriletes* species sporadically occur in the Hungarian Lower and Middle Cretaceous sediments. Their stratigraphic distribution, with the other bryophyte spores of Hungarian Early Cretaceous, are illustrated on the Table I.

Subclassis: Bryidae

Of the Lower and Middle Cretaceous spores, *Staplinisporites* and the *Coronatispora* formgenera show some similarity with the present-day moss spores. DETTMANN (1963) called the attention to the similarity between the recent moss spore *Encalypta ciliata* (HEDV.) HOFFM. and *Staplinisporites*. ČORNA (1968), SRIVASTAVA (1975) ranged the above formgenus among moss spores, while FILATOFF (1975) supposed a Lycopodiaceae relationship. On the basis of the ring at the distal surface of spore, I suppose that *Staplinisporites* and the *Coronatispora* are Bryidae.

Genus: Staplinisporites POCOCK 1962
Staplinisporites rotalis DÖRING 1964
(Plate I, Fig. 9)

Remarks: In the Hungarian sediments, this species exclusively occurs in Neocomian, in a low number of specimens.

Staplinisporites caminus (BALME 1957) POCOCK 1962
(Plate I, Fig. 10)

Remarks: This species is, together with some other forms, the characteristic species of the lower biozone of Vértessomló Formation.

Genus: Coronatispora DETT. 1963

Syn.: *Spinaecoronatisporites* DEÁK, p. 102.

Remarks: The opinions of some authors differ in respect of the problems of

nomenclature and priority. I accepted SRIVASTAVA's view (1975) who regards as a differential sign from the Staplinisporites the presence of interradial crassitudes.

Coronatispora valdensis (COUPER 1958) DETT. 1963
(Plate I, Fig. 11)

Conclusions

Of the spores of the Hungarian Early Cretaceous sediments, I have classed 24 species of ten genera — on the basis of their characteristic marks — among Bryophyta; from among them, the representatives of *Triporoletes, Aequitriradites, Coupe-*

Table 1. Stratigraphic distribution of Bryophyta spores from Hungarian Lower-and Middle Cretaceous.

	Bersek Formation	Sümeg Formation A	Sümeg Formation B	Tata Formation	Vértessomló Formation A	Vértessomló Formation B	Tés Formation	Pénzeskút Formation A	Pénzeskút Formation B
	Neocomian		Aptian		Albian				Low. Cen.
Staplinisporites rotalis	+	+							
Stereisporites sp$_1$.		+							
Stereisporites apolaris		+	+						
Stereisporites europeum			+	+	+		+		
Stereisporites australis			+		+				
Stereisporites cf. grossus					+	+			
Staplinisporites caminus				+	×	+			
Aequitriradites spinulosus		+			+		××	+	
Stereisporites sp$_2$.					×	+			
Stereisporites antiquasporites					+	+			
Triporoletes radiatus					×	+			
Triporoletes simplex					+	+	+		
Stereisporites aptiensis					+	+	×		
Foraminisporis dailyi						×	+		
Cingutriletes clavus							+	+	
Foraminisporis asymmetricus					××	+		+	+
Cingutriletes levispeciosus							+	+	
Triporoletes reticulatus							××	+	
Coronatispora valdensis							×	+	
Couperisporites clavatoides							××	+	
Phaeocerosporites purus							×	+	+
Coptospora sp.							+		+
Cingutriletes sp.								×	+

\+ rare
× common
×× very common

risporites, and *Coptospora* genera (six species) among Hepaticopsida; three species of Foraminisporis and Phaeocerosporites among Anthoceropsida. From the Sphagnidae subclass *Stereisporites* (nine species) and *Cingutriletes* (three species), from the Bryidae subclass *Staplinisporites* and *Coronatispora* (three species) have represented the Bryopsida. It can be established that Bryophyta played no important role in the studied microflora. According to the statement of SAMOILOVICH et al. (1973), in the areas above 60° Kr. N, in forming the Aptian-Albian microflora, the *Sphagnum* moors of wide extension had a considerable part. On the territory of that time of the present-day Hungary of tropic-subtropic climate, peat mosses had a subordinate role. Although I have identified most species from Sphagnaceae spores, the specimens of these were of very low number in each of the sporomorphe assemblages. The liverwort spores took a more important part than these in the Tés Formation. In the course of this sediments cycle, fresh-water assemblages of lagoon character developed and the sporomorphes of some rock samples give proof of the development of a coastal swamp vegetation. Thus, in the district of Olaszfalu and Tés, from the coaly-clayey samples, the following hornwort and liverwort spores were dominantly found: *Phaeocerosporites purus, Couperisporites clavatoides, Aequitriradites spinulosus, Triporoletes reticulatus, Coptospora* sp.

This indicates that in the swamp vegetation, apart from swampy ferns, Anthoceropsida and Hepaticopsida lived in the highest number. In the marine sediments, however, their part was entirely subordinated, even in the rocks of younger age.

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PALYNOLOGICAL INVESTIGATIONS ON AUSTRIAN UPPER CRETACEOUS AND LOWER TERTIARY SEDIMENTS

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Abstract

The strata of Haselhof (Maastrichtian), Haidhof (Danian), Oiching, Kleinoiching (L. Thanetian), St. Pankraz (U. Thanetian, L. Cuisian), Michelsberg (Cuisian) have been investigated palynologically. Of these the Thanetian sediments of Kleinoiching and St. Pankraz are rich in sporomorphs. Kleinoiching is rich in Gymnospermatophyte pollen grains with bladders and the *Normapolles* pollen grains, characteristic of the older strata, are also frequent. Of the Upper Thanetian and the Lower Cuisian the dominance of the Fagaceae pollen grains *(Cupuliferoipolleniles pusillus)* is characteristic. All in all, the demonstration of 86 sporomorphe species took place; of these, one is n. fgen. and together eight are n. fsp. The richness of the *Interporopollenites* is to be emphasized in the Lower Thanetian in Kleinoiching. This, and the occurrence of *Extratriporopollenites conjunctus*, as well as that of the *Tetrapollis* genus refer to the Danian, resp. the Paleocene (Monsian stage). The number of sporomorphs indicating an expressed tropical climate is low.

Introduction

Of the spore-pollen composition of the Lower Paleocene (Monsian) sediments in Austria an account was rendered in an earlier publication (KEDVES, 1970). By the results obtained the continuation of investigations was necessitated because the palynological problems of the transitional period of the Paleocene and the Upper Cretaceous are not solved within the *Normapolles* region, either. In this way, the palynological investigation into the Maastrichtian, Danian, Thanetian and Cuisian samples has taken place. The Maastrichtian and Danian samples are particularly important from the point of view of the development of the Upper Cretaceous — Lower Tertiary florae. The importance of the Upper Paleocene is given by that the number of the elements of the flora of the Lower Eocene is already considerable, as well. By the problem of the Cuisian, the spore-pollen assemblages of the Lower and Middle Eocene are affected.

Some Normapolles taxa ot the Lower Thanetian sediments of Kleinoiching took also place in our publication dealing with the taxonomy of the Paleocene Normapolles (KEDVES, HEGEDŰS—BOHONY, 1971).

Materials and Methods

The investigated material was given to my disposal by Dr. T. KECSKEMÉTI. For his kind help I wish to express my thanks in this way, too. The investigated samples are the following:
Maastrichtian: Haselhof, its mark is: A/4.
Danian: Haidhof, clayey fine sand, its mark is: B/7.
Lowest part of Thanetian: Oiching, dark-grey, clayey marl with fine sand, its mark is: DI/1c, Kleinoiching, dark-grey, sandy marl, its mark is: DI/2.
Upper part of Thanetian: St. Pankraz, dark-grey sandy marl, its mark is: DI/3a.
Lower part of Cuisian: St. Pankraz, its mark is: DI/3c. Cuisian: Michelsberg, its mark is: B/9.

In addition to these, Dr. I. Draxler (Geologische Bundesanstalt, Wien) sent several Danian and Paleocene samples; these, however, do not contain any sporomorphs.

Results

1) In the course of the investigations, the following taxa were described

Fgen.: *Interporopollenites* WEYL. et KRIEG. 1953

1. *Interporopollenites klausii* n. fsp. (Plate I, 11—14)

Diagnosis

Equatorial contour is triangular, generally with straight sides and rounded apices. The germinal area is a little prominent. The surface is smooth or finely scabrate. At the poles, there are triangular exine extenuations, these are generally different at the two poles; at one of them, they have the shape of an equilateral triangle with pointed apex; at the other pole, the apices are strongly rounded. This exine part is sometimes circular. The exopores are circular, generally 1.5 μ in diameter. The germinal areas are connected with about 2 μ wide arcuses at both sides. The extragerminal exine is generally 2 μ wide, its structure can only be observed with difficulty by means of a light microscope. But it can be established that the infratectum is thicker than the tectum, resp. the foot layer. The foot layer is strongly thickened in the germinal area; it is generally 2.5 — 3 μ and the endopore 4 μ wide generally.
Diameter: 26 μ, at other specimens: 19—28 μ.
Holotype: Plate I, 11, 12, slide DI/2—18; 7.1/116.2.
Locus typicus: Kleinoiching, lowest part of Thanetian.
Stratum typicum: Dark-grey, fine-sandy clayey marl.
Derivatio nominis: From Prof. DR. W. KLAUS, a prominent representative of the Austrian palynology.
Differential diagnosis: It is separeted from *I. zaklinskaiae* KDS. et HEG. 1975 by its wider endogerminalia and its less prominant germinal area and from the *I. stanleyi* KDS. et HEG. 1975 by the lack in vestibulum.
Occurrence: It is for the time being only known from the locality type.

2. *Interporopollenites draxlerae* n. fsp. (Plate I, 15—17, Plate II, 1)

Diagnosis

Equatorial contour is triangular, with straight or mildly concave sides. The apices are rounded, the germinal area is prominent. The size of exopores is about

2 μ, their shape is varied: slit-like, triangular or elliptical. The surface is finely punctate, the tectum is perforated. At the poles there are exine extenuations of irregular shape. The germinal areas are connected with 2.5 μ wide arcuses. The extragerminal exine is 2—2.5 μ thick, the tectum and foot layer are equally thin, about 0.5 μ. The infratectum is the thickest. Its structure cannot be recognized with light microscope but it is probably granular. The foot layer is very strongly thickened in the germinal area. There is a characteristic wedge-shaped endannulus. The endopore is 4—5 μ wide.
Diameter: 35 μ, at further specimens 30—38 μ.
Holotype: Plate I, 15, 16, slide DI/2—18; 5.7/107.2.
Locus typicus: Kleinoiching, the lowest part of Thanetian.
Stratum typicum: Dark-grey, fine-sandy clayey marl.
Derivatio nominis: From Dr. I. DRAXLER (Wien).
Differential diagnosis: It is separated from *I. thomsoni* KDS. et HEG. 1975 by its larger size and with the arcuses.
Occurrence: It is for the time being only known from the locality type.

3. *Interporopollenites kleinoichingi* n. fsp. (Plate II, 2—5)

Diagnosis

Equatorial contour is triangular, with straight sides and but a little rounded apices. The surface is smooth or finely scabrate. At the poles there are only very small exine extenuations of irregular shape. The exopores are circular or slit-like, with a maximum size of 1.5—2 μ. The extragerminal exine is 2—2.5 μ thick. Of the three layers of ectexine the infratectum is the thickest one. The tectum is thin, the foot layer is somewhat thicker than this. The infratectum is granulated. At the apices the tectum and the infratectal layer become thicker, the foot layer is separated from both outer layers. There is an expressed vestibulum. The endannulus is very thick (3—3.5 μ), the endopore is narrow, canal-like, its diameter being about 1 μ.
Diameter: 25 μ, at further specimens 21—27 μ.
Holotype: Plate II, 2, 3, slide DI/2—24; 7.1/117.4.
Locus typicus: Kleinoiching, the lowest part of Thanetian.
Stratum typicum: Dark-grey, fine-sandy clayey marl.
Derivatio nominis: From the locality type.
Differential diagnosis: It differs from *I. klausii* n. fsp. and similar pollen grains in the extenuation of the polar exine of small, irregular shape.
Occurrence: For the time being, it is only known from the locality type.

4. *Interporopollenites gregussii* n. fsp. (Plate II, 6—9)

Diagnosis

Equatorial contonur is triangular, with rounded apices, straight, mildly convex or concave sides. The germinal area is prominent. The surface is punctate or finely granulated. The exopores are elliptical, their maximum size is 2 μ. The extragerminal exine is 2—2. 5 μ thick. Of the three layers of the ectexine the infratectum, which is of granular structure, is the thickest one. Both two outer layers of the ectexine at the apices become strongly thick. The foot layer becomes strongly thick, as well, in the area of the pore. There is a 4 μ thick annulus. The endopore is generally 4 μ wide.

Diameter: 29 μ, at other specimens 27—30 μ.
Holotype: Plate II, 6, 7, slide DI/2—37; 12.8/115.9.
Locus typicus: Kleinoiching the lowest part of Thanetian.
Stratum typicum: Dark-grey, fine-sandy clayey marl.
Derivatio nominis: In honour of Prof. Dr. P. GREGUSS, the prominent palaeontologist.
Differential diagnosis: It differs from *I. subgranulosus* KDS. et HEG. 1975 in its essentially smaller endopores, as well as in its somewhat smaller size.
Occurrence: For the time being, it is only known from the locality type.

5. *Interporopollenites elsikii* n. fsp. (Plate II, 10, 11)

Diagnosis

Equatorial contour is triangular, with mildly concave sides, the apices are strongly rounded. The surface is smooth of finely scabrate. Both poles are concave triangular exine extenuation. The exopores are generally elliptical, their maximum size is about 2 μ. The extragerminal exine is 2—3 μ thick. Of the three layers of the ectexine the infratectum is the thickest, being of granular structure. The germinal areas are connected with arcuses. Both outer layers of the ectexine became thick in the germinal area. The foot layer becomes but a little thick round the endopores. The endannulus is not expressed. The endopores are generally 4 μ wide.
Diameter: 24 μ, at further specimens 23—28 μ.
Holotype: Plate II, 10, 11, slide DI/2—13; 15.3/115.5.
Locus typicus: Kleinoiching, the lowest part of Thanetian.
Stratum typicum: Dark-grey, fine-sandy clayey marl.
Derivatio nominis: From Dr. W. C. ELSIK a prominent researcher of the Paleogene sporomorphs.
Differential diagnosis: It differs from *I. klausii* n. fsp. in the lack of vestibulum, as well as in the extenuations of polar exine.
Occurrence: For the time being it is only known from the locality type.

6. *Interporopollenites* fsp. (Plate II, 12, 13)
Fgen.: *Kleinoichingipollenites* n. fgen.
Fgen. type: *Kleinoichingipollenites triangulus* n. fsp. (Plate II, 14, 15)

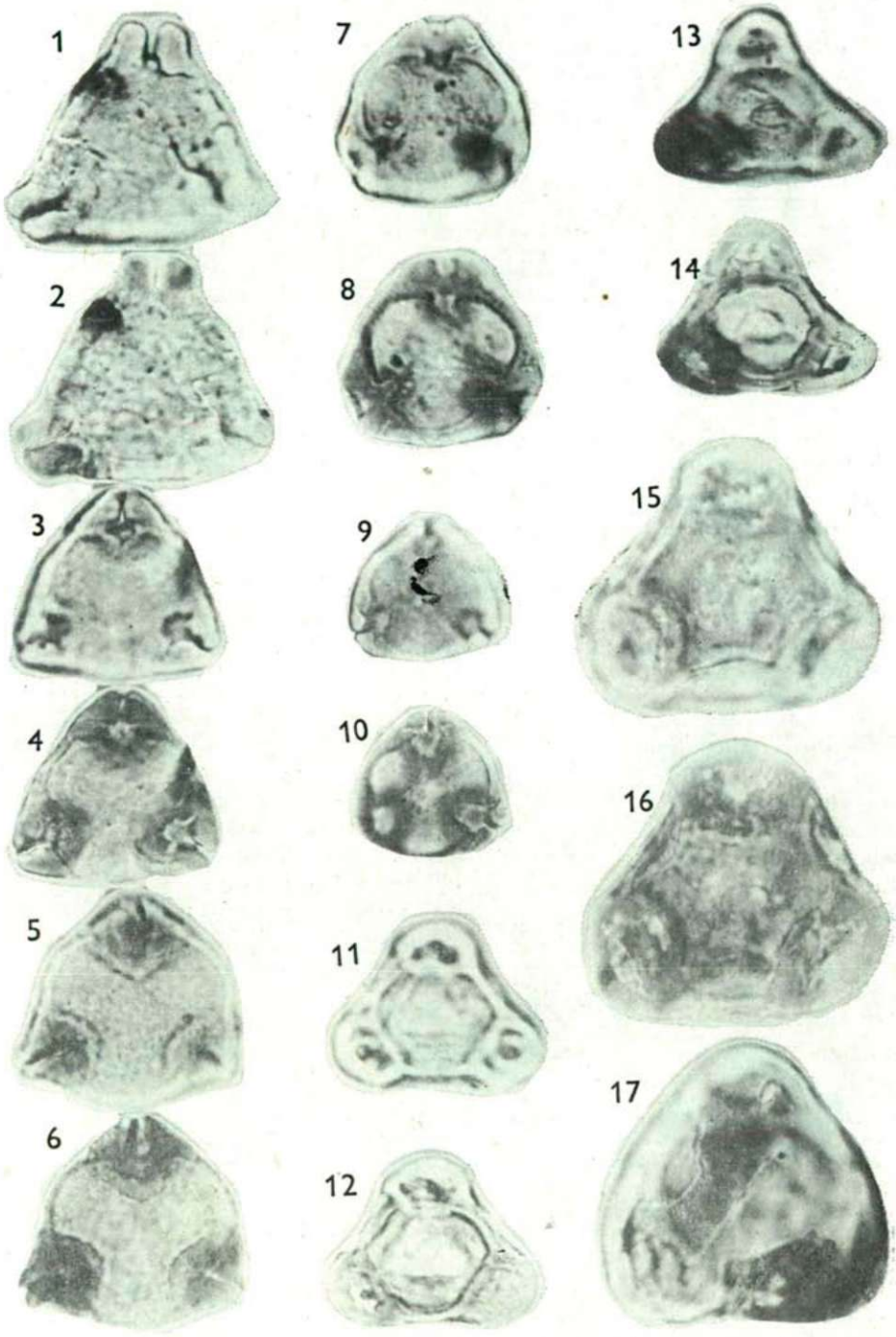
Diagnosis

Triangular pollen grains of three pores. The surface is smooth or finely scabrate.

Plate I

1, 2. — *Extratriporopollenites conjunctus* PF. 1953a, DI/2—27; 18.2/116.9
3, 4. — *Oculopollis exemplum* (PF. 1953a) n. comb., DI/2-26; 8.1/103.1.
5, 6. — *Oculopollis* fsp., DI/2—40; 16.9/102.6.
7, 8. — *Semioculopollis* fsp.$_1$, DI/2—35; 8.1/109.5.
9, 10. — *Semioculopollis* fsp.$_2$, DI/2—13; 13.5/115.0.
11, 12. — *Interporopollenites klausii* n. fsp., DI/2—18; 7.1/116.2.
13, 14. — *Interporopollenites klausii* n. fsp., DI/2—24; 13.2/104.6.
15, 16. — *Interporopollenites draxlerae* n. fsp., DI/2—18; 5.7/107.2.
17. — *Interporopollenites draxlerae* n. fsp., DI/2—26; 6.3/115.1.
x1000

Plate I



The germinal apertures are of equatoiral, rarely of subequatorial position. At the rim of pores there is a wavy laminiform appendage.
Locus typicus: Kleinoiching, the lowest part of Thanetian.
Stratum typicum: Dark-grey, fine-sandy clayey marl.
Derivatio nominis: From Kleinoiching, the locality type.
Differential diagnosis: The pollen grains belonging to the new genus described are well-separated from the pollen grains belonging to *Corsinipollenites* NAKOMAN 1965, as well as to *Triporopollenites* PF. et TH. 1953 by the appendages around the pores.

1. *Kleinoichingipollenites triangulus* n. fsp. (Plate II, 14, 15)

Diagnosis

Equatorial contour is triangular, with convex sides. The surface is finely scabrate. The extragerminal exine is 1—1.3 μ thick. Light-microscopically it only consists of ectexine. The tectum, infratectum and foot layer are equally thick. The diameter of pores is generally 2 μ, the appendage surrounding the exopores is 2.5—4 μ long and generally 0.5 μ wide. At the site of the beginning of the appendages of pores the exine becomes thin, generally 0.5 μ wide.
Diameter: 30 μ, at further specimens 27—32 μ.
Holotype: Plate II, 14, 15, slide DI/2—22; 8.7/110.7.
Locus typicus et stratum typicum: cf. at the diagnosis of fgen.
Derivatio nominis: From its triangular contour.

Fgen.: *Triporopollenites* PF. et TH. 1953

1. *Triporopollenites kleinoichingi* n. fsp. (Plate II, 16, 17)

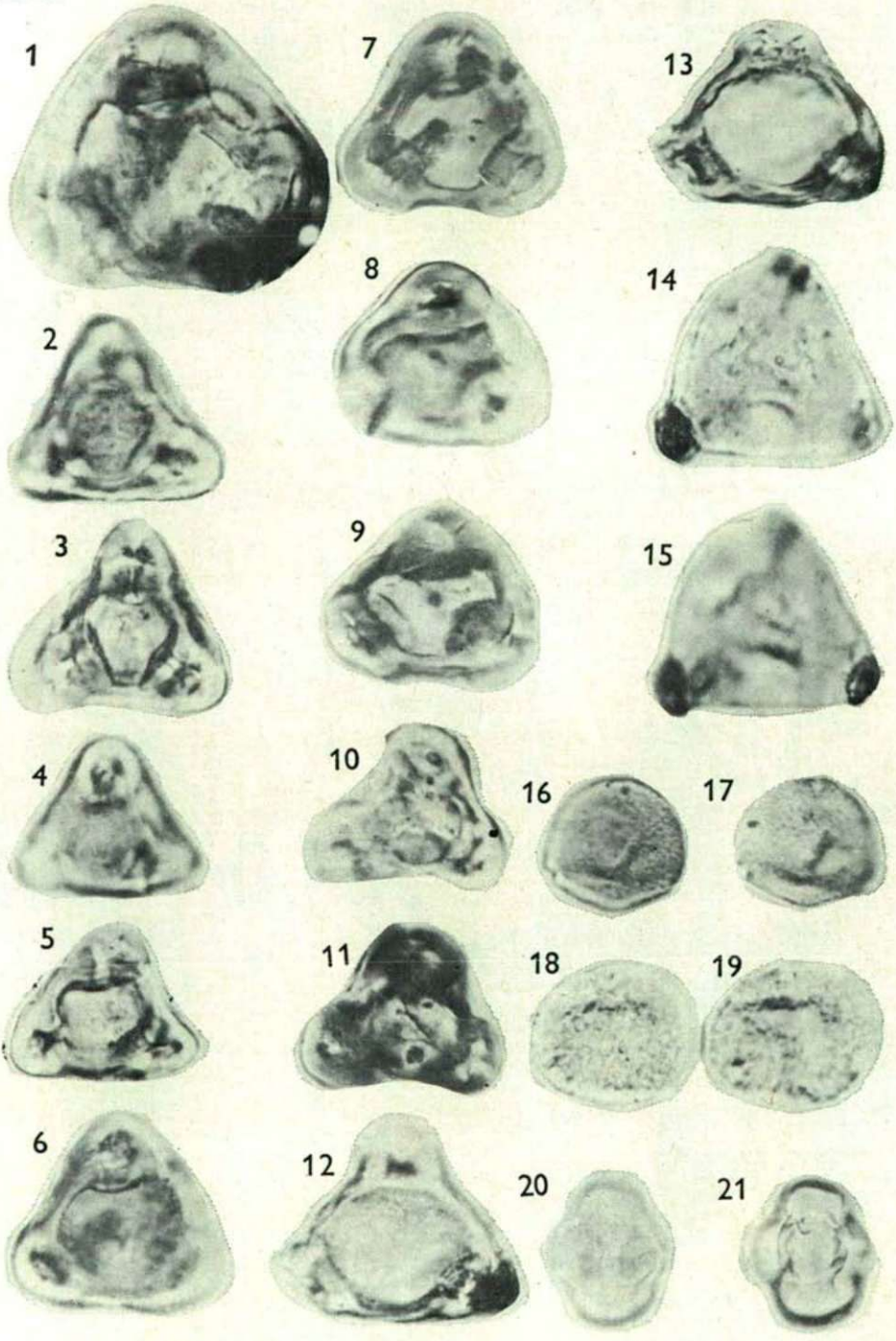
Diagnosis

Equatorial contour is triangular, with strongly convex sides. The extragerminal exine is very thin 0.5—0.6 μ, always below 1 μ; its stratification can be recognized with light microscope only with difficulty. The surface is granulated, the size of ornamental elements extends as long as 0.5 μ. The granules anastomose but rarely, when a fine rugulate ornamentation is produced. The diameter of pores is 1—2 μ, these are surrounded with a 0.6—1 μ wide annulus.
Diameter: 19 μ, at further specimens 16—22 μ.

Plate II

1. — *Interporopollenites draxlerae* n. fsp., DI/2—26; 6.3/115.1.
2, 3. — *Interporopollenites kleinoichingi* n. fsp., DI/2—24; 7.1/117.4.
4, 5. — *Interporopollenites kleinoichingi* n. fsp., DI/2—22; 16.6/117.3.
6, 7. *Interporopollenites gregussii* n. fsp., DI/2—37; 12.8/115.9.
8, 9. — *Interpopollenites gregussii* n. fsp., DI/2-13; 20.2/111.5.
10, 11. — *Interporopollenites elsikii* n. fsp., DI/2—13; 15.3/115.5.
12, 13. — *Interporopollenites* fsp., DI/2—22; 10.0/111.7.
14. 15. — *Kleinoichingipollenites triangulus* n. fgen. et fsp., DI/2—22; 8.7/110.7.
16, 17. — *Triporopollenites kleinoichingi* n. fsp., DI/2—11; 18.9/104.1.
18, 19. *Subtriporopollenites palaeocenicus* n. fsp., DI/2—14; 13.3/117.2.
20, 21. — *Tricolporate incertae* pollen DI/2—3; 6.8/106.8.
x1000

Plate II



Holotype: Plate II, 16, 17, prep. DI/2—11; 18.9/104.1.
Locus typicus: Kleinoiching, the lowest part of Thanetian.
Stratum typicum: Dark-grey, fine-sandy clayey marl.
Derivatio nominis: From Kleinoiching, the locality type.
Differential diagnosis: It is well-separated from the pollen grains classified into the form-genus by means of its ornamentation.
Occurrence: For the time being it is only known from its locality type.

Fgen.: *Subtriporopollenites* PF. et TH. 1953

1. *Subtriporopollenites palaeocenicus* n. fsp. (Plate II, 18, 19)

Diagnosis

Equatorial contour is circular or elliptical. The pores have a 2—2.5 μ diameter, they are narrow, with a 0.5—0.8 μ annulus. The extragerminal exine is 1—1.5 μ thick, it consists light-microscopically only of ectexine; the tectum, infratectum and the foot layer are equally thick. The sculpture is fine rugulate, the width of the ornamenting elements is 0.5 μ. There are rarely also some verrucae among the rugulate ornamental elements.

Diameter: 22 μ, at further specimens 18—26 μ.
Holotype: Plate II, 18, 19, prep. DI/2—14; 13.3./117.2.
Locus typicus: Kleinoiching, the lowest part of Thanetian.
Stratum typicum: Dark-grey, fine-sandy clayey marl.
Derivatio nominis: From the geological age of the stratum typicum.
Differential diagnosis: It can be separated from *S. constans* PF. 1953a subfsp. constans by means of its finer ornamental elements and the sporadically occurring verrucae.
Occurrence: Kleinoiching, the lowest part of Thanetian, Haidhof, Danian.

Longaxones

Tricolporate incertae pollen (Plate II, 20, 21)

2. Sporomorphs demonstrated in the course of investigations

Fgen.: *Leiotriletes* (NAUMOVA 1937) R. ROT. et KRP. 1954

L. adriennis (R. POT. et GELL 1933) W. KR. 1959, Schizaeaceae cf. *Lygodium* (DI)1c, DI(3), *L.* cf. *microadriennis* W. KR. 1959, Schizaeaceae cf. *Lygodium* (DI)/1c), *L. dorogensis* (KDS. 1960) KDS. 1961, Schizaeaceae, cf. *Lygodium* (DI/2), *L.* fsp.$_1$ (DI/1c), *L.* fsp.$_2$ (DI/2).

Fgen.: *Stereisporites* TH. et PF. 1953

Form-subgenus: *Stereisporites (Distgranisporis)* W. KR. 1963

St. (Distgranisporis) fsp., Sphagnaceae (DI/2).

Fgen.: *Toroisporis* W. KR. 1959

T. (Toroisporis) ecoenicus KDS. 1966, cf. Gleicheniaceae (DI/2), *T. (Toroisporis) guinetii* KDS. 1973, cf. Gleicheniaceae (DI/3c), *T. (Toroisporis)* fsp., cf. Gleicheniaceae (DI/2).

Fgen.: *Gleicheniidites* (ROSS. 1949) W. KR. 1959 *Gl. (Gleicheniidites)* fsp., Gleicheniaceae (DI/2).

Fgen.: *Undulatisporites* PF. 1953

U. fsp., Gleicheniaceae (DI/1c).

Fgen.: *Echinatisporis* W. KR. 1959

E. longechinus W. KR. 1959, Selaginellaceae, *Selaginella* (DI/2).

Fgen. *Ischyosporites* BALME 1957

I. asolidus (W. KR. 1959) W. KR. 1967, Schizaeaceae (DI/1c, DI/2).

Fgen.: *Cicatricosisporites* R. POT. et GELL. 1933 *C. dorogensis* R. POT. et GELL. 1933 subfsp. *dorogensis,* Schizaeaceae, *Anemia* (DI/1c, DI/2), *C.* fsp., Schizaeaceae, *Anemia* (DI/2.)

Fgen.: *Polypodiaceoisporites* R. POT. 1956

P. fsp., Pteridaceae, *Pteris* (DI/2).

Fgen.: *Verrucingulatisporites* KDS. 1961

V. fsp. (DI/2).

Fgen.: *Camarozonosporites* PANT 1954 ex R. POT. 1956

Form-subgenus: *Camarozonosporites (Hamulatisporis)* W. KR. 1959

C. (Hamulatisporis) bellus (MARTYNOVA 1960) KDS. 1973, Lycopodiaceae, *Lycopodium* (DI/2).

Fgen.: *Laevigatosporites* IBR. 1933

L. haardti (R. POT. et VEN. 1933) TH. et PF. 1953 subfsp. *haardti,* Polypodiaceae (DI/2).

Fgen.: *Pityosporites* SEWARD 1914

P. microalatus (R. POT. 1931)TH. et PF. 1953, Abietaceae, *Pinus* (DI/1c, DI/2), *P. labdacus* (R. POT. 1931) TH. et PF. 1953 subfsp. *labdacus,* Abietaceae, *Pinus* (DI/1c, DI/2, B/7).

Fgen.: *Cupressacites* BOLCHOVITINA 1956

C. hiatipites (WODEH. 1933) W. KR. 1971, Taxodiaceae v. Cupressaceae (DI/2).

Fgen.: *Inaperturopollenites* TH. et PF. 1953

I. concedipites (WODEH. 1933) W. KR. 1971, Taxodiaceae (DI/1c, A/2).

Fgen.: *Ephedripites* BOLCH. 1953 ex R. POT. 1958 *E. (Ephedripites)* fsp., Ephedraceae, *Ephedra* (DI/1c).

Fgen.: *Extratriporopollenites* (PF. 1953a) PF. 1953b *E. conjunctus* PF. 1953a (Plate I, 1, 2; DI/2).

Fgen.: *Trudopollis* PF. 1953b em. W. KR. 1967 *T. nonperfectus* (PF. 1953a) PF. 1953b (Plate II, 11, 12, in KEDVES et al. 1971; DI/2), *T. subperfectus* (PF. 1953a) PF. 1953b (Plate III, 1, 2, in KEDVES et al. 1971; DI/2), *T. hemiperfectus* (PF. 1953a) PF. 1953b (Plate III, 6, 7, in KEDVES et al. 1971; DI/2), *T. orthomechanicus* (PF. 1953a) PF. 1953b (Plate III, 3—5, in KEDVES et al. 1971; DI/2), *T. varioreticulatus* (STELMAK 1960) ZAKL. 1963 (Plate II, 13—15, in KEDVES et al. 1971; DI/2).

Fgen.: *Oculopollis* PF. 1953b

O. exemplum (PF. 1953a) n. comb. (Plate I, 3, 4; DI/2).

Syn.: 1953a PFLUG — *Extratriporopollenites exemplum* n. sp., p. 75, 6, 102—105

1953b PFLUG — *Trudopollis exemplum* (PFLUG) n. comb. p. 100, Pl. 25, 50.

O. fsp. (Plate I, 5, 6; DI/2).

Fgen.: *Semioculopollis* GÓCZÁN, W. KR. et PACLT. 1967

S. fsp.$_1$ (Plate I, 7, 8; DI/2), *S.* fsp.$_2$ (Plate I, 9, 10; DI/2).

Fgen.: *Pompeckjoidaepollenites* Pf. 1953b em. W. Kr. 1967

P. subhercynicus (W. Kr. 1954) W. Kr. 1967 (Plate III, 14—19, in Kedves et al. 1971; DI/2).

Fgen.: *Nudopollis* Pf. 1953b

N. endangulatus (Pf. 1953a) Pf. 1953b (DI/2), *N. terminalis* (Pf. 1953a) Pf. 1953b (Plate II, 6—8, in Kedves et al. 1971; DI/2), *N. thiergartii* (Th. et Pf. 1953) Pf. 1953b (Plate II, 1—5, in Kedves et al. 1971; DI/2), subfsp. *conspicuus* Pf. 1953a (DI/2), subfsp. *minutus* Pf. 1953a (DI/2).

Fgen.: *Interporopollenites* Weyl. et Krieg. 1953 *I. klausii* n. fsp. (Plate I, 11—14; DI/2), *I. draxlerae* n. fsp. (Plate I, 15—17, Plate II, 1, DI/2), *I. kleinoichingi* n. fsp. (Plate II, 2—5; DI/2), *I. gregussii* n. fsp. (Plate II, 6—9 DI/2), *I. elsikii* n. fsp. (Plate II, 10, 11; DI/2), I fsp. (Plate II, 12, 13; DI/2).

Fgen.: *Interpollis* W. Kr. 1961

I. supplingensis (Pf. 1953) W. Kr. 1961 (DI/2, DI/3a), *I. microsupplingensis* W. Kr. (1961 (DI/2), *I. velum* W. Kr. 1961 (DI/2, DI/3c).

Fgen.: *Plicapollis* Pf. 1953b

P. pseudoexcelsus (W. Kr. 1958) W. Kr. 1961 subfsp. *turgidus* Pf. 1953a, Myricaceae (DI/2, DI/3a), subfsp. *semiturgidus* Pf. 1953a, Myricaceae (DI/2), subfsp. *minor* Pf. 1953a, Myricaceae (DI/2, DI/3a, DI/3c).

Fgen.: *Vacuopollis* Pf. 1953b

V. concavus (Pf. 1953a) W. Kr. 1960 (DI/2).

Fgen.: *Minorpollis* W. Kr. 1959

M. gallicus Kds. 1969 (DI/2)

Fgen.: *Stephanoporopollenites* Th. et Pf. 1953

St. hexaradiatus (*Thg.* 1940)

Th. et PF. 1953 subfsp. *hexaraditus* (DI/2, A/2), subfsp. *tribinae* W. Kr. 1961 (DI/2).

Fgen.: *Tetrapollis* Pf. 1953b

T. validus (Pf. 1953a) Pf. 1953b (Plate IV, 1—3, in Kedves et al. 1971; DI/2).

Fgen.: *Kleinoichingipollenites* n. fgen.

K. triangulus n. fsp. (Plate II, 14, 15; DI/2).

Fgen.: *Plicatopollis* W. Kr. 1962

Pl. plicatus (R. Pot. 1934) W. Kr. 1962, Juglandaceae (DI/2).

Fgen.: *Platycaryapollenites* E. Nagy 1969

P. fsp., Juglandaceae, *Platycarya* (DI/3c).

Fgen.: *Triatriopollenites* Pf. 1953a

T. sauerae (Gladkova 1965) Kds. 1974, Myricaceae (DI/1c), *T. intermedius* (Gladkova 1965) Kds. 1974, Myricaceae (DI/3a), *T. minimus* (Gladkova 1965) Kds. 1974, Juglandaceae, *Engelhardtia* (DI/3a), *T. sibiricus* (Gladkova 1965) Kds. 1974, Myricaceae (DI/2), *T. conspicuus* (Gladkova 1965) Kds. 1974, Myricaceae (DI/2), *T. microcoryphaeus* (R. Pot. 1931) Sontag 1972, Myricaceae (DI/2, DI/3), *T. bituitus* (R. Pot. 1931) Th. et Pf. 1953, Myricaceae (DI/2), *T. roboratus* Pf. 1953a, Myricaceae (DI/2, A/2, B/7), *T. pseudogranulatus* (Gladkova 1965) Kds. 1974, Myricaceae (DI/2).

Fgen.: *Momipites* Wodeh. 1933

M. quietus (R. Pot. 1934) W. Kr. 1972 (DI/2).

Fgen.: *Triporopollenites* Pf. et Th. 1953 *T. nointelensis* Kds. 1960, Corylaceae

(DI/2), *T. robustus* PF. 1953a subfsp. *robustus,* Betulaceae (DI/2), *T. coryloides* PF. 1953a, Corylaceae (DI/3c), *T. kleinoichingi* n. fsp. (Plate II, 16, 17; DI/2).

Fgen.: *Subtriporopollenites* PF. et TH. 1953

S. constans PF. 1953a subfsp. *constans,* Juglandaceae (DI/2, DI/3a), subfsp. *magnus* W. KR. 1961, Juglandaceae (DI/2, DI/3a), *S. subporatus* W. KR. 1961 subfsp. *subporatus,* Juglandaceae (DI/2, B/7), *S. anulatus* PF. et TH. 1953 subfsp. *anulatus,* Juglandaceae cf. *Carya* (DI/2), *S. palaeogenicus* n. fsp. (Plate II, 18, 19, DI/2, B/7).

Fgen.: *Intratriporopollenites* PF. et TH. 1953

I. microreticulatus MAI 1961, Tiliaceae (DI/2).

Fgen.: *Duplopollis* W. KR. 1959

D. fsp., Myrtaceae (DI/1c).

Fgen.: *Pentapollenites* W. KR. 1958

P. triangulus W. KR. 1962 (DI/2).

Fgen.: *Monocolpopollenites* TH. et PF. 1953

M. tranquillus (R. POT. 1934) TH. et PF. 1953 subfsp. *tranquillus,* Palmae (DI/2, DI/3a, DI/3c).

Fgen.: *Sparganiaceaepollenites* THIERGART 1937 *S. cuvillieri* (GRUAS-CAV. 1966) W. KR. 1970, Sparganiaceae (DI/1c).

Fgen.: *Cupuliferoidaepollenites* R. POT. 1960 *C. liblarensis* (THOMS. in POT., THOMS. et THIERG. 1950) R. POT. 1960, Fagaceae v. Leguminosae (DI/1c, DI/3a, DI/2), *C. quisqualis* (R. POT. 1934) R. POT. 1960, Fagaceae v. Leguminosae (DI/2, B/7, DI/3c).

Fgen.: *Cupuliferoipollenites* R. POT. 1960

C. pusillus (R. POT. 1934) R. POT. 1960, Fagaceae cf. *Castanea* (DI/1c, DI/3a, DI/2, B/7, DI/3c), *C. oviformis* (R. POT. 1931) R. POT. 1960, Fagaceae, *Castanea* (DI/3a, DI/2, A/2, DI/3c).

Fgen. *Psilatricolporites* (Van der HAMMEN 1956) Van der HAMMEN et WIJMSTRA 1964

Ps. parmularius (R. POT. 1934) KDS. 1978, Eucommiaceae (DI/2), Ps. fsp. (DI/1c).

Fgen.: *Striatricolporites* (Van der HAMMEN 1956) LEIDELMEYER 1966

S. fsp. (DI/2).

Longaxones incertae sedis

Tricolporate incertae pollen (Plate II, 20, 21; DI/2).

Fgen.: *Tetracolporopollenites* PF. et TH. 1953

T. oblongus PF. et TH. 1953, Sapotaceae (DI/1c), *T. halimbaense* KDS. 1961, Sapotaceae (DI/2).

Apart from sporomorphs, we could also observe other microfossils: *Botryococcus, Pediastrum, Concentricystes* (=Pseudoschizaea), *Pleurozonaria concinna* (COOKSON et MANUM 1960 MADLER 1968, Hystrichosphaeridae, chitin-framed Foraminiferae.

3. Quantitative data

3.1. Maastrichtian

Haselhof

The investigated sample is poor in sporomorphs. Normapolles are few, resp. there did not occur in any forms characteristic of this period. The presence of *Stephanoporopollenites hexaradiatus* is rather referring to the Paleocene, Monsian or

Thanetian age.

3.2 Danian

Haidhof

In this locality as well, we could only observe a few sporomorphs. *Triatriopollenites roboratus* is the only „old Tertiary" pollen grain.

3.3 Monsian

Oiching

The results relating to this can be found in KEDVES's publication (1970). The composition of the sporomorphs of suitable quantity refers to the typical lower Paleocene period.

3.4 Thanetian

Lowest part of Thanetian

Oiching

There are only few sporomorphs but their composition is interesting. The content of 38.7 per cent spores and 3.2 per cent plankton refers to an open assemblage. This is supported by Sparganiaceae and Myricaceae, as well, indicating the vegetation of a river-side bog. The 25.8 per cent pine-pollen grains with bladders give the character of an extrapalustral forest. The quantity of the pollen grains of the marsh Gymnospermae — Taxodiaceae v. Cupressaceae — is very small.

Kleinoiching

It is extremely rich in sporomorphs. The quantity of spores is small (9.5 per cent). Plankton organisms (*Botryococcus, Pediastrum, Concentricystes, Pleurozonaria concinna,* Hystrichosphaeridae) are similarly few 4.7 per cent. Angiospermae represent 38.3 per cent in the spore-pollen spectrum. The ratio of Gymnospermae (47 per cent) is the highest and within this, the amount of those with bladders is abundant (40.2 per cent). Within Angiospermae, the ratio of *Normapolles* is 30.4 per cent. The riverside vegetation is characterized by the 33.6, resp. 23.6 per cent ratio of Myricaceae and ancient Juglandaceae (*Carya* type). In the extrapalustral vegetation, in addition to the *Pinus* genus, Fagaceae are also considerable.

St. Pankraz (a level more closely not specified, of the Thanetian stage)

In contrast to the above-mentioned Thanetian localities, the number of pine pollen grains is but a minimum, not more than 4 per cent. It is interesting that there occurred no pine pollen with bladders at all in this locality. The ratio of spores, Hystrichosphaeridae and Foraminiferae is similarly low, 1 per cent each. The dominating role of Angiospermae in the spore-pollen spectrum is outstanding: 93 per cent. Within Angiospermae, Fagaceae dominate (85.7 per cent), indicating a semiterrestrial marshy environment. Myricaceae are 7.6 per cent, Juglandaceae 3.2 per cent, Normapolles 3.2 per cent. In this way, the quantity of the palustral-forest elements is but a minimum.

3.5 Cuisian

Lower Cuisian

St. Pankraz

The sporomorphous quantity is middle-sized. The pollen grain of Fagaceae, *Castanea*-type is dominant. From the point of view of geological age, Interpollis velum and *Plicapollis pseudoexcelsus* minor are considerable. The beginning of the

Middle Eocene tropical flora is indicated by the higher number of Palmae pollen grains.

Michelsberg (a level of Cuisian, not specified more closely)
This exclusively contains Hystrichosphaeridae remnants.

Discussion

The demonstrated microscopic remnants refer to the following taxa:
Chrysophyta, Xanthophyceae, Heterochloridales *(Botryococcus)*.
Chlorophyta, Chlorophyceae, Chlorococcales *(Pediastrum)*, Bryophyta, Musci, Sphagnales *(Sphagnum)*.
Pteridophyta, Lycopsida, Lycopodiales *(Lycopodium)*, Selaginellales *(Selaginella)*.
Pteropsida, Leptosporangiatae, Filicales, Schizaeaceae (cf. *Lygodium, Anemia)*, Gleicheniaceae, Polypodiaceae, Pteridaceae *(Pteris)*.
Gymnospermatophyta, Coniferopsida, Pinales, Abietaceae *(Pinus)*, Taxodiaceae v. Cupressaceae.
Ephedropsida, Ephedrales, *(Ephedra)*.
Angiospermatophyta, Dicotyledonopsida, Hamamelidales, Eucommiaceae, Leguminosae, Myrtiflorae, Myrtaceae, Malvales, Tiliaceae, Ebenales, Sapotaceae, Fagales, Betulaceae, Corylaceae, Fagaceae *(Castanea)*, Juglandaceae (*Platycarya, Engelhardtia,* cf. *Carya)*, Myricaceae, Monocotyledonopsida, Palmales, Palmae, Pandanales, Sparganiaceae.

In respect to the climatic conditions of the Paleocene it is to be established by reason of the present results, as well, that in its vegetation the number of the expressed tropical elements is comparatively low. This is shown partly by ferns, partly by Palmae. The plants pollinated by wind are widely distributed, while the species and individual number of plants pollinated by insects is very low. The outstanding dominance of the Pinus genus in the sediments of Oiching and Kleinoiching considered as Thanetian is particularly interesting. This is namely known beginning from the Upper Eocene. But it is characteristic of the upper part of the Oligocene when a further pine type with bladders, the *Picea* genus also appears. The richness of the modern pine pollen grains in form and individual is characteristic of the Neogene.

In connection with the stratigraphic value of spore-pollen assemblages of the investigated sediments the following comments are to be made:

The Maastrichtian age of Haselhof is not probable, owing to the occurrence of the typical forms of *Stephanoporopollenites hexaradiatus* hexaradiatus. This pollen type characterizes in Europe the Paleocene very well and can be divided by its subfsp. well. The problem needs some further investigations. By reason of the data so far, Monsian or the lower part of Thanetian is the most probable age.

In the lower Thanetian of Kleinoiching the co-called „old forms" are very frequent. These are characteristic partly of the Upper Danian *(Extratriporopollenites conjunctus, Tetrapollis validus, T. polyangulus)*, partly they are characteristic taxa rather of the Upper Cretaceous (*Trudopollis nonperfectus, T. subperfectus, T. hemiperfectus, T. orthomechanicus, Oculopollis exemplum, Interporopollenites* fspp.). It can, therefore, be possible that a number of the pollen grains of *Normapolles* are redeposited. This possibility is, however, not supported by the state of preservation of sporomorphs. It is much more possible that the strata of Kleinoic-

hing that are considered as Thanetian, are of older age. As a probable geological age, the Upper Danian or Lower Monsian can be given.

It is to refer here to our results achieved at the Monsian strata of Oiching. It is interesting that Kleinoiching is very rich in pollen grains originating from the Upper Cretaceous which can be found only restrainedly in the Monsian strata of Oiching; on the other hand, the "old Postnormapolles" *(Triatriopollenites pseudovestibulum, T. aroboratus)* occur just here. The lack of fgen. *Interporopollenites* in the Monsian is worth mentioning. This is supporting the conclusion that the taxa of plants producing this pollen type — on the basis of electron-microscopic data, the ancient Juglandales — are facies-sensitive.

We could not observe any pollen grains of typical Paleocene Angiospermatophytes from the Thanetian strata of Oiching. The spore-pollen assemblage first of all refers to the conditions of the sedimentary process, cf. with the high percentage of Pteridophytes.

The *Stephanoporopollenites* genus, which is very characteristic of the age, was not found from the Thanetian strata of St. Pankraz. At any rate, the Plicapolis, Interpollis, *Subtriporopollenites* constans refer to the old Tertiary.

The problem of Cuisian is still to be clarified by means of further investigations. The vegetation history of the transition from the flora of the Lower Eocene to that of the Middle Eocene and on the basis of this its pollen stratigraphy demand further investigations.

Finally, the palynology of the sediments of the Austrian Upper Cretaceous — Lower Paleogene cannot be considered as closed. Several problems have been raised by the present investigations as well. Particularly the solution of the problem of the Danian and Cuisian needs further investigations. These results are very important from the point of view of the Paleogene of the Carpathian basin, as well, because in the Lutetian a tropical vegetation existed. This had developed from the Lower Eocene flora, the question of which cannot be regarded as closed down even today.

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HISTOLOGICAL AND MORPHOLOGICAL COMPARISON OF THE LEAVES OF CYDONIAE

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Abstract

We have carried out leaf-morphological and leaf-histological investigations into Cydoniae from Bereczk (B), Constantinople (C), and Leskovác (L).

We have compared the length of leaf-blade, its largest breadth, and the length of leaf-stalk with the morphological characterization of leaves. To the histological investigations we have made, as usual, a preparation by maceration, and cross-sections with celloidin embedding. We have compared our data, which are in every case averages of 100 measurings, with T-test and Wilcoxon's test. On the basis of our results, we can make the following statements .

From among the morphological characteristics of leaves of the three Cydonia sorts, there is a significant difference in the length of leaf-stalks, in the breadth of leaf-blades, and in the full length of leaves (petiole+lamina of leaf).

There is a significant difference (0.1) between the cell- and stoma-numbers of the lower-side epidermis. On the other hand, the difference in the epidermis cell-numbers is not even at 5 per cent level between the sorts B and L. The highest is the stoma-index of quince L.

The ratio of participation of the spongy parenchyma is the highest in sort L (1.8) and decreases in the sequence of sorts C (1.25) and B (1.03). We have observed a positive correlation between the size of fruit (average weight)and the relative thickness of the spongy parenchyma, in case of the three investigated sorts.

On the basis of tissue characteristics there is a closer relationship between sorts B and C.

Introduction

Literary survey

As compared with the other fruit sorts, the sort number of quince *(Cydonia oblonga* MILL.) is low even on a world scale.

The number of the registered sorts is, according to BRÓZIK—REGIUS (1957) not more than 7 to 10 in this country. According to our investigations, in Hungary quinces B and C, planted in about 47 per cent each, are the best known. It is difficult to differentiate these, as well as quince L, cultivated in Jugoslavia, on the basis both of their vegetative and generative properties. To the reliable determination of the three sorts the above authors give a direction on a morphological basis. They use from among the vegetative properties the size and form of leaves for characterizing sorts. From among the generative organs, they compare the sorts on the basis of flower and fruit.

The literature, dealing with the quince, is also poor. Apart from the above works, we used, as well, the works by G. KRÜßMANN (1951, 1960), M. MOHÁCSI—A. PORPÁCZY (1954), Á. JESZENSZKY (1966), A. TODOR (1970), J. RAYMAN—P. TOMCSÁNYI (1964), R. RAPAICS (1940), and the statistical publications, listed in References. Histological data are to be found in various comprehensive descriptions. The tissue structure of the stem is dealt with by P. GREGUSS (1945), METCALFE, G. R.—CHALK, L. (1954); the morphology, tissues and chemical composition of the fruit and seed, the stone cells to be found in the fruit by HALMAI—NOVÁK (1963), G. KASSTEN, and U. WEBER (1951), B. HAZSLINSZKY—L. TAKÁCS (1960).

The aim of our work is to characterize the quince sorts from Bereczk, Constantinople, and Leskovác, on the basis of the morphological and histological signs of leaves. We have compared the dimensions of leaf sizes, as well as the quantitative, dimensional data of the tissue elements of the leaf with the average weights, which are characteristic of the sorts of fruit, as well.

Materials and Methods

The investigated sorts of quince are: those from Bereczk, Constantinople, Laskovác (further marked with the letters B, C and L). For the investigation we have used some individuals originated from the same habitat and showing the morphological characteristics of sorts well. The number of the investigated individuals is: from B, K there are 5 each, from L 4. For the morphological comparison of leaves, we have measured 100 full-grown leaves of each sort. These were taken in equal rate from the edge, bottom, middle and inner regions of the foliage.

For comparison the following data were used:

Length of the leaf-blade: L (distance between points A—B).
Breadth of the leaf-blade: B (distance between points D—E).
Length of the leaf-stalk: LS (distance between points B—C).

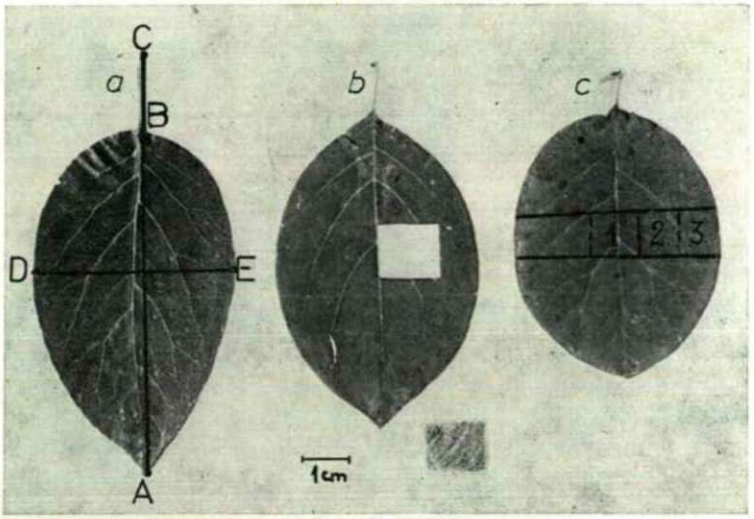


Fig. 1. a) Measuring points used for comparison b) Sampling into the investigation of the epidermis c) Sampling to the cross-section investigation of the leaf.

From the data we have calculated the full length of the leaf (A—C), as well as the ratio of the breadth (D—E) and length (A—B) of the leaf-blade.

The epidermis of the leaf was compared on the basis of the following data: epidermis cell number (E), the number of stomata (S), the length of closing cells (L), the breadth of closing cells (B), the ratio of breadth and length of the closing cells (B/L), stoma-index (I). For investigating the epidermis we have used leaves taken from the region of foliage because, according to our earlier investigations (PATAKY, 1969), with the exception of the B/L, ratio of the closing cells, as well as the length of these, we have found differences in the investigated properties within the same individual.

Sampling for the preparation for maceration (Fig. 1, b) took always place from the identical region of the leaf-blade. This is justified by that some differences can be observed even between the samples taken from different places of the same leaf, in respect of the measurable properties of the epidermis (Mrs. SIMON—MOLNÁROS, 1964; MARÓTI, 1965; GULYÁS, 1961, etc.).

For analysing the mesophyll, we made a cross-section and measured the full thickness of the leaf-blade (in μ): mesophyll+surface and lower-surface epidermis (Fig. 1, c: according to samples 1, 2, 3). Within this, we measured the thickness of the palisade and spongy parenchymas separately (in μ).

The different properties were compared on the basis of 100 survey data, with a double-sample T-test and Wilcoxon's test.

For the leafy-crown shape, characteristic of the sorts, and the fruit average weights, we have used the data of BRÓZIK—REGIUS (1957) MOHÁCSI—PORPÁCZY (1954).

Results and evaluation of the investigations

1) External morphological Observations:

The sort of longest leaf-stalk and largest leaf-blade is quince B. The measurements of sort L are the smallest, and those of sort C form a transition between both. In respect of the form of leaf, the same can be established (Fig. 2).

In the length of the leaf-stalk, the sorts show a significant difference at 5 per cent level. In the length of the leaf-blade, only sort L differs at 5 per cent significance level from the other two sorts. The breadth of the leaf-blade gives a difference in significance at 5 per cent level, between the single sorts.

We find a difference in significance, similarly at 5 per cent level, in the full length of the leaf in all the three cases, despite that sorts C and B do not show any difference, if we investigate one of the components of the measuring point (the length of the leaf-blade).

The shape of the leaf can be well characterized with the B/L ratio of the leaf-blade. Sort L differs from the two others, at 5 per cent level, in this property. The form of this is namely the most round. For the other two sorts, we have obtained values, which are near each other both in size and shape. (Cf.: Table 1)

Our survey results concerning the external morphology of the leaf support Brózik-Regius's characterization of quince sorts B, C, and L (1957), which can be used well in practice, as well, and according to which, the leaves of quince B are

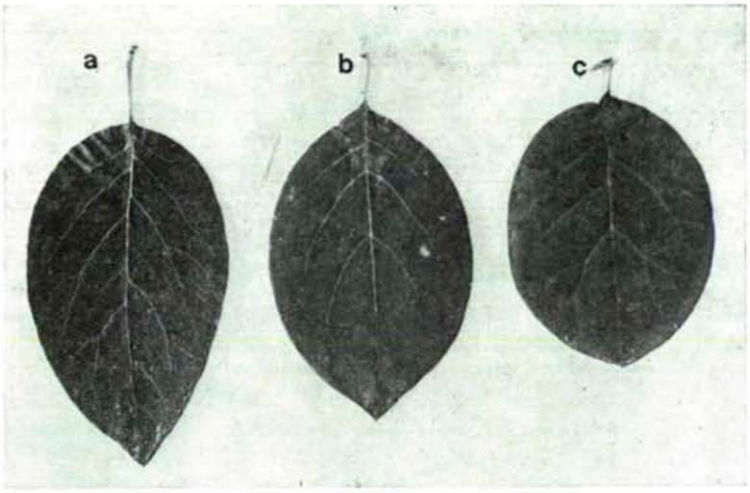


Fig. 2. Leaf forms of the quince sorts from Beretzk (a), Constantinople (b), and Leskovác (c).

very large and the most long-shaped, those of sort L are the most roundish and the smallest ones. Sort C may be put, in size, too, between the two other leaf shapes. As to the leaf-stalk, we have got other results. We have found a continuous tarnsition between the investigatec sorts in respect of the length of the leaf-stalk. According to our measurings, quince B has the longest leaf-stalk, then the length of the leaf-stalk decreases in the sequence of sorts C and L.

Table 1. Morphological comparison of the leaves of quince sorts B (Bereczk), C (Constantinople) and L (Leskovác).

Measured property	sorts	average	maximum	minimum	sample dispersion	average dispersion
Length of leaf-blade in mm	B	82	110	59	1.06	0.10
	C	79	117	57	0.11	0.16
	L	62	87	46	0.76	0.07
Breadth of leaf-blade in mm	B	57	70	42	0.83	0.08
	C	52	72	38	0.07	0.73
	L	46	60	36	0.49	0.04
Length of leaf-stalk in mm	B	17	25	11	0.29	0.02
	C	12	16	10	0.01	0.14
	L	10	13	7	0.15	0.01
Full length of beaf in mm	B	99	130	73	1.26	0.26
	C	92	131	67	0.12	1.24
	L	72	99	56	0.88	0.08
B/L ratio of the leaf-blade	B	0.69	0.82	0.59	0.07	0.007
	C	0.65	0.84	0.54	0.06	0.006
	L	0.74	0.94	0.61	0.05	0.005
B/L percentage of the leaf-blade	B	69	82	59	7.00	0.70
	C	65	84	54	6.00	0.60
	L	74	94	61	5.00	0.50

As a result of the different environmental effects, the measurements of the leaf (primarily the leaf area or leaf size) strongly change.

For instance, under the influence of the intensity of illumination (VERKERK, 1955; BEAN, 1964), of the daily total energy quantity (NEWTON, 1963), under the influence of geographical latitude, of the height above sea level (BREZHNEV, 1955), etc. We can, therefore, characterize with the obtained data first of all the formal properties of the single sorts and can describe the degrees of the differences between sorts.

2) Histological observations

a) General characterization and histological comparison of the epidermis

It is characteristic of all the three sorts of quince that the leaves are hypostomatic. Stomata placed scatterred in the leaf-vein islands are somewhat prominent from the level of epidermis. On the basis of Van Gotthem's classification (1971), the openings of the aspiratory metabolism are of anomocytic type, i.e., the closing cells are not surrounded by side cells. The downiness of the leaves is induced by the intergrown network of the unicelluler, long drawn-out covering hair of the thin cell-wall (Plate III picture 1).

The radial wall of the epidermis cells is of wavy course viewed from above. The degree of waviness (its amplitude and denseness) — particularly in sorts B and C — is stronger at the lower surface than at the upper one (Plates II, III.) At the surface epidermis cells, the striation of the epidermis cuticle, which generally follows the longitudinal axis of cells, is characteristic (Plate II, picture 4).

Results of our measuring are summarized in Table 2. (Cf. Table 2)

The size of the surface epidermic cells is the largest in sort B, the smallest in sort C These differ from each other even at a 0.1 per cent significance level. Sorts B and L however, give not any measurable difference even at 5 per cent level.

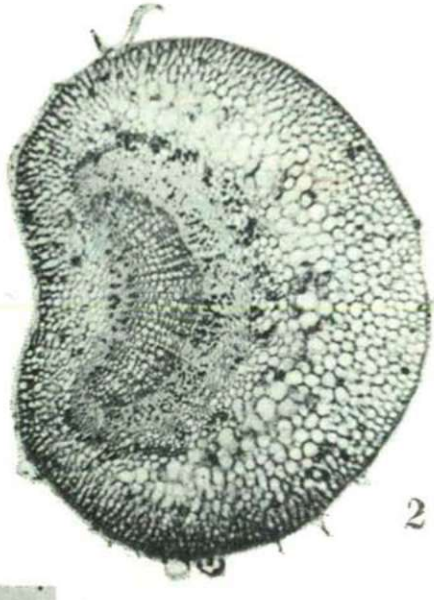
On the basis of the lower surface epidermic cell number, falling on the areal unit, epidermic cells of sort L with the smallest leaf-blade have the largest size. The differences in size are more important at the lower surface because in a joint comparison and in that by pairs (B—C, C—I, L—C) too, the there sorts show a significant 0,1 per cent difference.

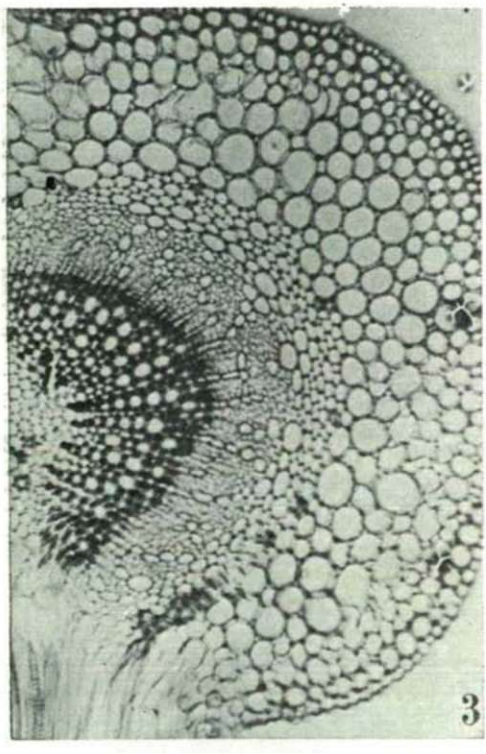
We have observed a well-perceptible difference in stoma-number between the three investigated sorts, both compared by pairs and jointli at a 0.1 per cent significance level as well. (Cf. with Table 2)

The stoma index (the ratio of stoma-number and epidermic cell number referred to an areal unit) in the leaves of sort L is strikingly high (13.72), as compared with that of the other two sorts. It is almost double of sort C and differs from sort L, as well, at a 0.1 per cent significance level.

In respect of the length of closing cells, sorts B—C—L are in a decreasing sequence. Between the closing-cell lengths of sorts B and L, a 0.1 per cent significant difference can be established. In breadth, at a 5 per cent level, the two sorts show some difference. Both in length and in breadth, at a 1 per cent level, there is some difference between sorts B—C and C—L.

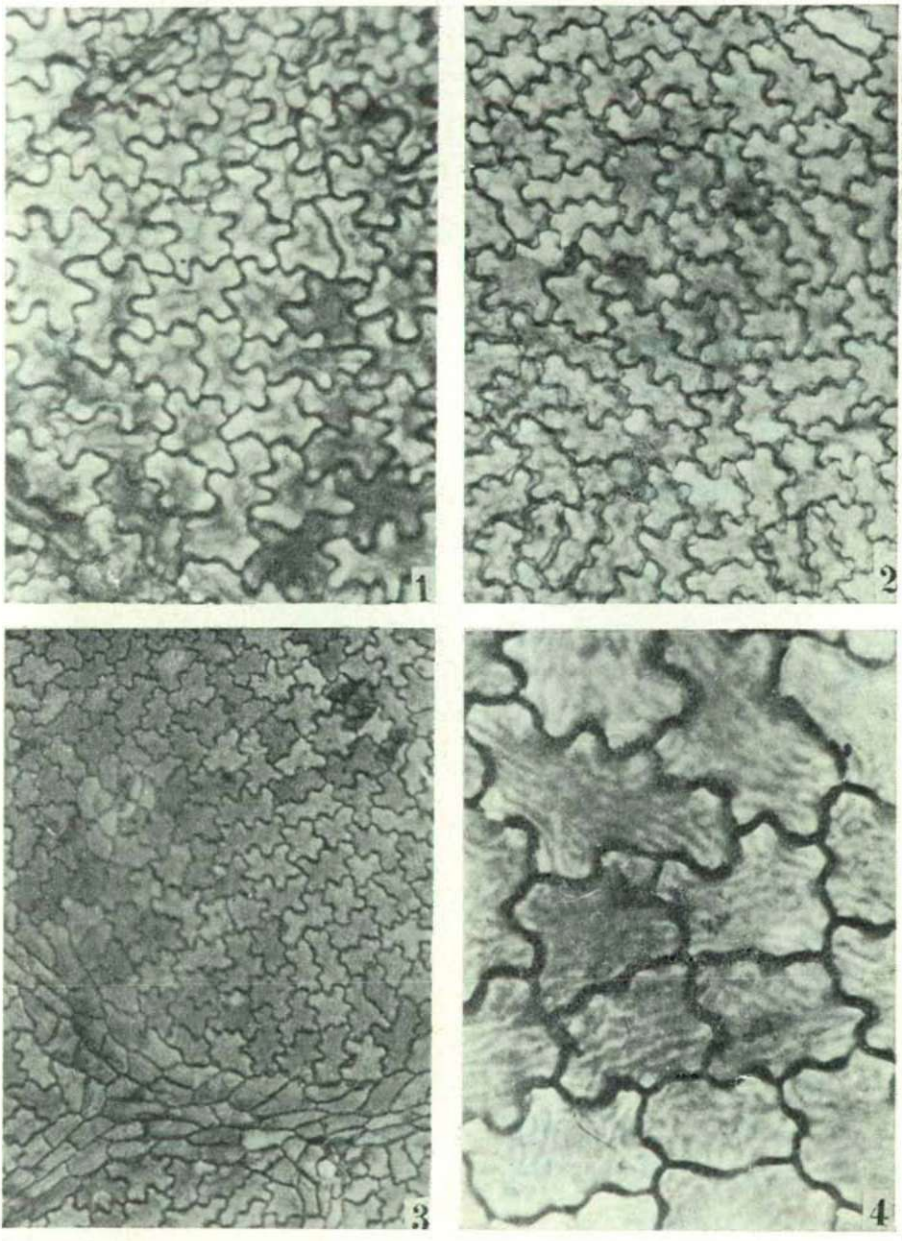
Plate I





Pictures 1, 4. Leaf cross-section (B), Magnification: ×240 and ×49.6
Picture 2. Leaf-stalk cross-section (B), magn.: ×36
Picture 3. Main vein cross-section (B), magn.: ×305

Plate II



Surface epidermis
Picture 1. Bereczk, magn.: ×305
Picture 2. Leskovác, megn.: ×198 quince sorts
Pictures 3, 4. Constantinople, magn.: ×198 and ×600

In the B/L ratio — which this form may be characterized by — there is a 1 per cent significant difference only between sorts B—L and C—L. In respect of the form of closing cells, sorts B—C cannot be separated. On the basis of our measuring, we have found "the most round" stomata at sort L, while those of sorts B and C were more elongated.

Though stoma-number and stoma-index seem to be characteristics, which change less as a result of ecological effects as referred to an areal unit of leaf than the epidermic cell unit; they are yet alone not sufficient in this way either, to delimit some taxonomical categories (species, possibly sorts) (KURSANOV, 1952; Mrs. SIMON—MOLNÁROS, 1964; GULYÁS, 1961; MARÓTI, 1965, 1961; GREGUSS, 1962).

The conservative tissue characteristics are primarily formal properties, e.g. the form of the epidermic cells, the type of stomata, the form of closing cells. (B/L). The joint application of these with other properties, which are less, affected by ecological effects first of all on the basis of the lower surface epidermis, e.g., stoma-index possibly stoma-number, can reliably be applied even in (the identificatioo of sorst, if in) these properties the investigated sorts significantly deviate from one another.

(It is interesting to note that BRÓZIK—REGIUS (1957), found the following characteristics of the form of leaves: the form of the leaf of quince B is: broad — oval,

the form of the leaf of quince C is: roundish, broad, oval,

the form of the leaf of quince L is: very broad, elliptical, sometimes roundish.

It could only be decided on the basis of further investigations whether the forms of leaves and closing cells, the close correlation between their ratios, are accidental or there is a connection between the measured data).

b) General characterization and histological comparison of the mesophyll

The mesophill of all the three kinds of leaves is of a heterogeneous construction, with a double cell-lined, columnar multi-cell-layer spongy parenchyma (Plate I, picture 1). The spongy parenchyma in the investigated sorts is of a loose structure. The intercellular spaces are much larger than the cell body (Plate III, picture 2). The main vein and the major leaf veins protrude at the side of the lower surface. The collaterally closed vascular bundle of the main vessel is limited kollenchyma, which is hollow towards the side of the lower surface epidermis. The bundle is curved in a crescent form. The phloem is bordered by sclerenchyma bundles, as in the stalk (Plate I, pictures 3, 4).

Our data measured in the leaf cross sections are summarized in Table 3.

Between the investigated three sorts there is — even at 0.1 per cent level — a significant difference in the thickness of leaf-blades. Sort B has the thinnest leaf (131.56 μm). The largest average leaf-thickness was found in sort C (245.33).

There are some differences in the thickness of the palisade parenchyma as well. The difference between sorts C—B and C—L manifests itself at 0.1 per cent significance level as well; but between sorts B—L, only at 1 per cent significance level (Fig. 3).

In respect of thickness of the spongy parenchyma, all the three sorts differ from one another, even at 0.1 per cent level.

If we compare the thickness of the palisade and spongy parenchymas with the full thickness of the leaf, there are differences between the single sorts at a lower

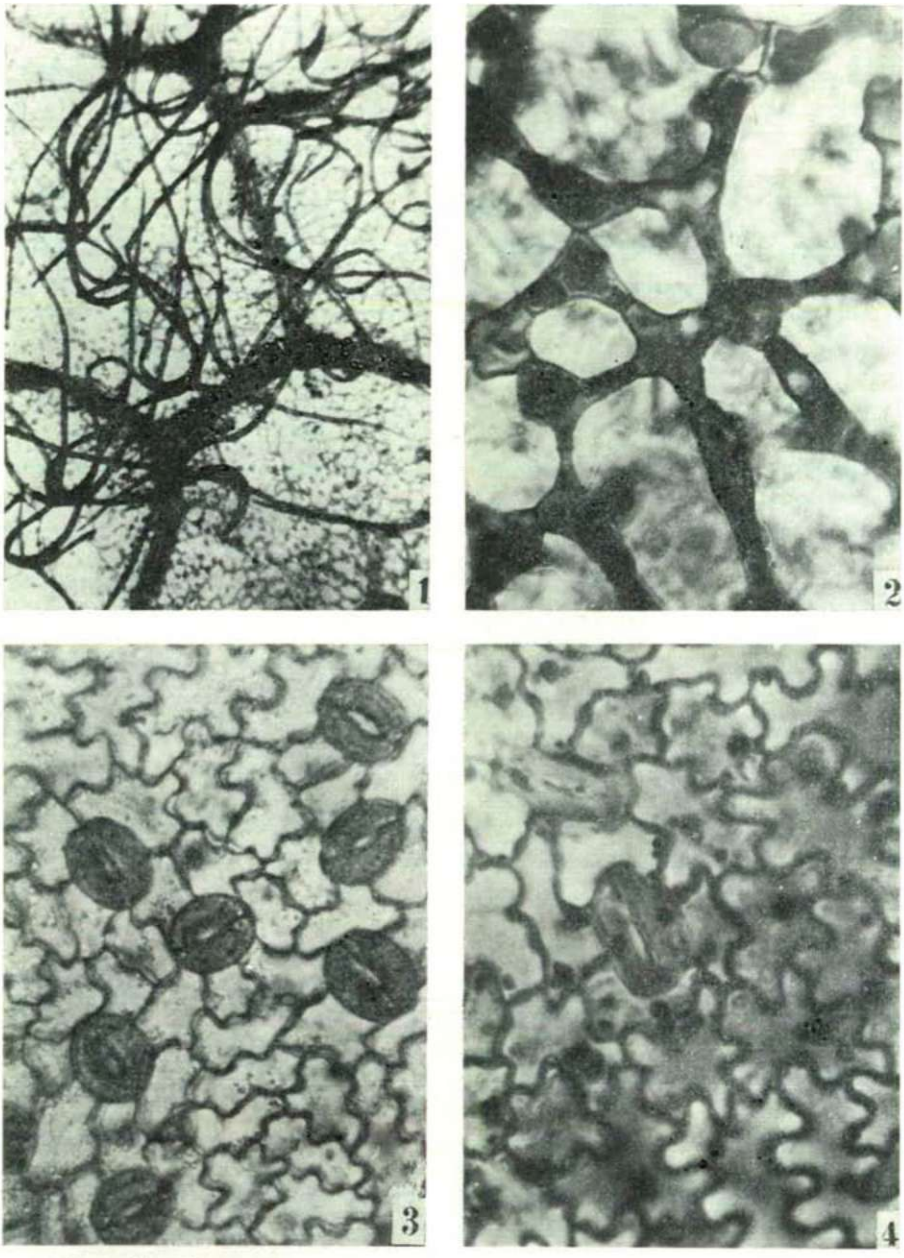
Table 2. Measurement results of the epidermis of quince sorts B (Bereczk), C (Constantinople), and L (Leskovác).

Measured properties	Sorts	Average		Maximum		Minimum		Sample dispersion		Average dispersion	
		upper surface	lower surface	upper surface	low. surface	upp. surface	low. surface	upp. surface	low. surface	upp. surface	low. surface
Epidermic cellnumber/sq. mm	B	953	2803	1184	3360	752	2496	6.44	12.8	0.64	1.28
	C	1001	3064	1200	4000	782	2480	6.08	17.9	0.60	1.79
	L	972	2300	1344	2976	800	2240	6.40	18.3	0.64	1.83
Stoma number/sq. mm	B		268		384		208		2.4		0.24
	C		233		320		144		2.9		0.29
	L		366		512		224		4.4		0.44
Length of closing cells μm	B		27.12		31.25		23.75		1.4		0.14
	C		22.75		29.15		17.50		1.7		0.17
	L		21.50		25.00		17.50		1.3		0.13
Breadth of closing cells μm	B		15.00		19.75		12.50		1.2		0.12
	C		12.62		16.25		8.75		1.2		0.12
	L		14.50		17.50		12.50		1.0		0.10
B/L ratio of the closing cells	B		0.55		0.71		0.45		0.05		0.005
	C		0.56		0.72		0.41		0.06		0.006
	L		0.67		0.82		0.57		0.04		0.004
Stoma index	B		8.72		8.25		7.69		9.90		0.99
	C		7.07		7.40		4.82		15.00		1.50
	L		13.72		14.67		9.09		13.90		1.39

Table 3. Measurement results of the cross-section of the leaf
B = Berezck, C = Constantinople, L = Leskovác.

Measured properties	Sorts	Average	Maximum	Minimum	Sample dispersion	Average dispersion
Total thickness of the leaf-blade in μm	B	131.56	148.75	112.50	0.76	0.67
	C	245.33	290.00	212.50	13.46	1.34
	L	160.15	173.75	148.75	4.43	0.44
Thickness of palisade parenchyma in μm	B	54.45	66.25	43.75	3.82	0.38
	C	94.91	123.75	58.75	10.67	1.06
	L	50.28	62.75	45.00	4.40	0.44
Thickness of spongy parenchyma in μm	B	56.35	70.00	40.00	2.41	0.24
	C	126.55	150.00	102.50	9.74	0.97
	L	85.86	96.25	75.00	3.38	0.33
Ratio of the total thickness of the leaf-blade p.p.	B	2.36	2.69	2.09	1.60	0.16
	C	2.63	2.41	2.21	6.40	0.64
	L	3.18	4.02	2.04	4.29	0.42
Ratio of the total thickness of the leaf-blade spongy parenchyma	B	2.32	3.09	2.04	5.92	0.59
	C	1.91	2.25	1.61	1.15	0.11
	L	1.87	2.10	1.67	1.27	0.12
Ratio of spongy par. palisade parenchyma	B	1.03	1.82	0.80	1.62	0.16
	C	1.25	2.30	1.05	1.10	0.11
	L	1.80	2.08	1.50	0.78	0.07

Plate III



Lower surface epidermis
Picture 1. Bereczk, magn.: ×63 quince sorts
Pictures 2, 4. Constantinople, magn.: ×600 and ×770
Picture 3. Leskovác, magn.: ×600

significance level in the ratio of participation of the palisade paranchyma than in that of the spongy parenchyma. It is in the former case at 1 per cent significance level between sorts B—C, L—C and at 5 per cent significance level between B—C.

On the other hand, in the participation ratio of the spongy parenchyma, there is no difference between sorts C—L, even at 5 per cent significance level.

The thickness ratio of the spongy parenchyma and palisade parenchyma (sp.p./p.p.) is different within the leaves the three sorts.

This ratio is the highest for the good of the spongy parenchyma in sort L: 1.8 (53.6 per cent) and differs from that of the other two sorts at 1 per cent significance level. It is in sorts B and C 1.3 (43 per cent), resp. 1.25 (51.5 per cent); these differ from each other only at 5 per cent significance level.

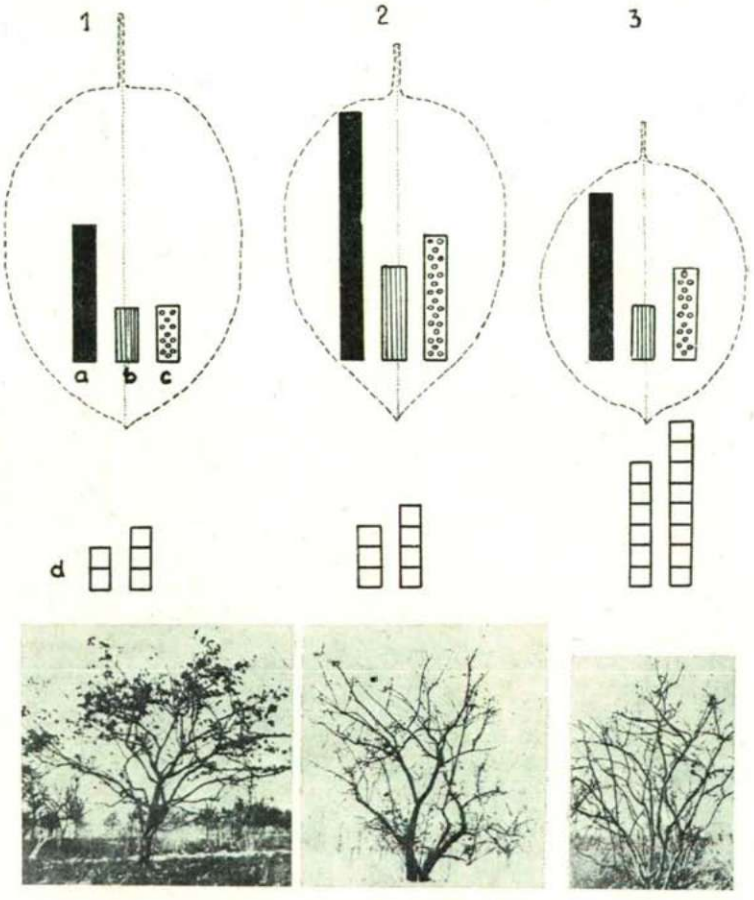


Fig. 3. Sizes, forms of the leaf, fruit, and tree Quince sorts from Bereczk (1), Constantinope (2), and Leskovác (3).

a) thickness of the leaf-blade μ
b) thickness of the spongy parenchyma μ
c) thickness of the palisade parenchyma μ
d) average weight of fruit, 100 g

Summarizing our results concerning the cross section of the leaf, it is to be established that unambiguously essential (0.1 per cent) differences between the three sorts can be found in absolute value — in the thickness of leafblades and in that of the spongy parenchyma. The designation, used by BRÓZIK—REGIUS (1957): "lighter" for sort B and "of the darkest leaf" for sort C, may originate from the considerable differences in the thickness of lamina, as well. These two data are however, considerably affected by water supply. BREZHNEV (1955) demonstrated, namely, that in the irrigated areas the lamina becomes thicker, the quantity of the spongy-parenchyma cells multiplies.

And not only the effect of water supply can be considered as generally valid to the change in the tissue structure. The geographical latitude, the height above sea level (BREZHNEV 1955), the intensity of light (e.g., GRAHL & WILD, 1973; STARZECKI, 1958; TAKÁCS, 1973), the spectral composition of light (e. g., HORVÁTH, 1975 PATAKY—HORVÁTH, 1978) also induced essential changes in the leaf-blade or, within the leaf, in the absolute thickness of the palisade parenchyma, in the size of the spongy and palisade parenchyma-cells, in the number of the cell-rows of the spongy parenchyma, as well as in the ratio of spongy parenchyma and palisade parenchyma.

The data and ratios, measured in the cross-section of the leaf, can — owing to the considerable changes in them — less be used for characterizing species and sorts.

In respect of ratios, there are no unambiguously essential differences between the investigated sorts. At the same time, we can observe a surprising connection between the increase of the percentage of the palisade parenchyma (L=32.0 per cent, C=38,7 per cent, B=41.5 per cent) and between the formation of the leafy crown of the investigated sorts, the size of trees, characteristics of sorts, as well as between the average fruit weights and the development of the spongy parenchyma (Fig. 3).

Table 4. Values of the double-sample T-test, summarizing the morphological properties of the leaf (Bereczk = B, Constantinople = C, Leskovác = L).

Compared property	Compared sorts	T value	Freedom degree
Length of leaf-blade	B & C	− 1.545	+198
	L & B	− 15.134	+192
	C & L	+ 12.533	+174
Breadth of leaf-blade	B & C	− 9.142	+198
	L & B	− 16.630	+161
	C & L	+ 6.618	+173
Length of leaf-stalk	B & C	− 16.169	+143
	L & B	− 21.886	+148
	C & L	+ 9.309	+198
Full length of leaf	B & C	− 4.282	+198
	L & B	− 21.667	+198
	C & L	+ 12.787	+178
B/L ratio of leaf-blade	B & C	− 10.805	+187
	L & B	− 1.712	+182
	C & L	− 10.713	+198

Table 5. Values of Wilcoxon's test, comparing the epidermes of the three quince sorts (where the dispersion of the three samples agreed at a 95 per cent level, T-value and freedom degree are published).

Compared property	Compared sorts	U-value
Surface-epidermic cell count	B & C	3709.5
	L & B	4667.0
	C & L	3964.0
Lower surface-epidermic cell count	B & C	2221.0
	L & B	864.0
	C & L	T-value: −18.62 Freed. d.: +198
Stoma number	B & C	3038.0
	L & B	1120.0
	C & L	591.5
Length of the closing cells	B & C	503.0
	L & B	61.5
	C & L	3314.0
Breadth of the closing cells	B & C	1478.0
	L & B	4100.5
	C & L	1932.5
B/L ratio of the closing cells	B & C	T-value: −0.7195 Freed. degr. +191
	L & B	376.0
	C & L	698.0
Stoma-index	B & C	791.0
	L & B	1220.0
	C & L	964.0

The question may come up, whether the close correlation between the above data was a matter of a mere chance. STARZECKI (1958, 1962) regards the spongy parenchyma as the fundamental mesophill tissue of the leaf from the point of view of the main function of the leaf. He attributes to the palisade parenchyma primarily the role of a light-filter. This hypothesis seems to be verified by other histological observations, too, in connection with the change in the intensity of light (e.g., GRAHL—WILD, 1973; TAKÁCS, 1973; PATAKY—HORVÁTH, 1978). But we consider as convincing Maróti's opinion (1976), as well, according to which in the palisade parenchyma the first photochemical system dominates. The first photochemical system, which is independent of the second pigment system, may have a part in the cellulose synthesis, in the growth of cell-walls (in determining the size of tree) (MARÓTI —GÁBOR, 1976).

On the basis of the above hypothesis, there can arise the possibility, too, that the spongy parenchyma may possibly have a more important role in the production of fruit and of the accumulated organic matter than that of the palysade parenchyma.

Table 6. U-values of Wilcoxon's test, comparing the leaf cross-sections of the three sorts.

Compared property	Compared sorts	U-value
Total thickness of the leaf-blade	B & C	2815.50
	L & B	3109.00
	C & L	2200.00
Thickness of the palisade parenchyma	B & C	1120.0
	L & B	951.50
	C & L	2038.00
Thickness of the spongy parenchyma	B & C	579.00
	L & B	397.00
	C & L	503.00
Ratio of the total thickness of leaf-blade/p.p.	B & C	3964.00
	L & B	591.50
	C & L	1020.05
Ratio of the total thickness of leaf-blade/sp.p.	B & C	4660.00
	L & B	3967.00
	C & L	T-valuelx: −18.67 Freed. d.: +198
Ratio of the spongy p./palisade p.	B & C	4050.00
	L & B	791.00
	C & L	864.00

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THE SYMMETRY OF LIVING BEINGS
I. THE DECREASE IN SYMMETRIES AND EVOLUTION

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Abstract

It seems to be a general property of nature that the (atomic and cellular) organizing of matter resp. anti-matter can only take place of particles of a single kind of helicity.

The asymmetry of components does not mean that the living beings (the composition) are (is) also unambiguously asymmetrical.

The main manifestation of the onto- and phylogeny is: the decrease in symmetries, the formation of the evolutional series of symmetry states. The complete asymmetry, however, means decline, stagnancy, because a higher organization can only be achieved by cells (forms) that have preserved their symmetry.

The cause of the formation of helix symmetries is the damage to cylinder symmetries. The helix is a new, stable state of the linear formation, the manifestation of the cylinder symmetry at a higher level.

In the living world, Fibonacci's series is followed by every helix symmetry, because this takes the arrangement 1+1, the most ancient cylinder symmetry, as its starting point.

Are living beings asymmetrical?

The laws of nature are approximately symmetrical. Nevertheless, in the living world we find several instances of asymmetry. Looking at ourselves in the mirror the heart of our reflected image beats on the right side. Were the symmetry of reflection full then people of the same number should live with hearts on the right and left sides. Similarly, the right- and left-handers should amount to the same number.

The shells of most snail species, living in our days, are whorled to the right. A distinction, like this, may often be met with in the vegetable kingdom as well: e.g., the hop-vine ramps on the hop-pole to the left but the stalk of bean has a winding to the right. We do not know any bean or hop species, among which we could find stalks winding to right and to left in the same number. However, not the morphological asymmetry of the organs but the molecular asymmetry is considered as the main argument for the universal asymmetry of the living world. The living beings are built only of one of the possible two stereoisomers.

These facts are well-known. The question is, however, whether we can draw the conclusion from them that living beings are unambiguously asymmetrical. We are of this opinion.

In physics, symmetries have an outstanding significance. In biology, however,

an undeservedly low attention has been payed to them. In connection with the raised question, I take it important to discuss the following subjects:

(1) The concept of symmetry, the principles of symmetry in nature,
(2) The main manisfestation of evolution, decrease in symmetries and increase in co-ordination,
(3) *Helix* symmetries in the living world.

1. The concept of symmetry, the principles of symmetry in nature

In art and science people have always been attracted by the perfect things or by those damageable only a little. In our environment, symmetry generally means geometrical regularity. It may be seen, therefore, justified for answering the question, "what symmetry is," to set out first from geometry. According to the definition of the mathematician Weyl: Something is symmetrical if it can be subjected to a certain operation and after performing this operation it remains the same as before.

The main characteristics of the performable operations or, by another name, symmetry-transformations are: turning round in space, shifting in space and time, on the other hand: reflecting.

1.1. Continuous transformation

Turning round and shifting are also named continuous transformation because starting out of a position, we can get with any small steps into the wanted new position.

The most symmetrical spacial form is the sphere because it may have in its centre innumerable axes, passing through, and turning round it remains the same as it was earlier.

The cylinder has already no more than one axis, round which it can be turned in any degree and, after turning we shall see it the same as before.

The symmetrical tranformations of the square are poorer. It can be turned unchanged at a plane by 90, 180, and 270 degrees. And round the four bisecting axes at the plane we don't observe any change only in case of a turning by 180 degrees.

An entirely regular pentapetalous flower is even less symmetrical than the square. If it is turned round the sole axis in its centre, there will only be four cases — the removal by 72, 144, 216, 288 degrees — when the petals get into a position that is undistinguishable from the original position.

We find, of course, also some "bodies" in nature that — in case of a spatial turning — being pushed in a direction — pass into themselves. Taking into consideration the shift, as well, the symmetry of the highest degree is shown by gases (homogeneous isotropic systems). In the system all points, all directions are equivalent, sphere-symmetrical.

In crystals, all points are also equivalent but there are already some distinguished directions (axes), too, along which the crystals, shifted by one or more rows of atoms, are found unchanged. The crystals are homogeneous, anisotropic systems.

In the vegetable kingdom, the carbohydrate polymers consist only of one of the two possible isomers, the "right-hand" D-glucose. In the starch and cellulose hemicrystals we find some axes, along which all "points" are equivalent. This is a

nice example that symmetrical structures can be created even from asymmetrical molecules, at a higher level of organization.

If we consider the cell as an elementary unit, then a homogeneous cell filament, a cell plate is also symmetrical. If we shift a linear series of cells like this in the field of sight of the microscope by one or more cells along the longitudinal axis, the, new picture remains exactly the same as the former one was.

1.2. Space reflection is the symmetry of the right and left

Reflection is a geometrical forming (transformation), in the course of which distances remain unchanged. Reflection is also named discrete symmetry because the transformation — in contrast to the continuous space — time symmetries — can only be performed in a single step.

The discrete symmetry transformation may be: space reflection, time reflection and filling reflection (transposition of matter — antimatter). The fundamental characteristics of reflection is that if the operation is performed successively, two times the initial position returns.

The image of a point P reflected on the system of co-ordinates yz be P'. The transformation means in the co-ordinates of the point the following:

$$x' = -x, y' = y, z' = z$$

After reflecting on plane, the reflected image of formations entirely agrees with the original one. The bisecting plane of the sphere, cube, cylinder, square, etc. is, at the same time, a reflecting plane, as well. The reflected image of several symmetrical molecules (e.g., H_2O, CH_4) can be turned so that it covers the original molecule. These "bodies" have no "right-hand(and'left-hand" varieties.

The image of point P° reflecting the origo of the system of co-ordinates is P. But at the reflection referring to the origo, we get the following change:

$$X^0 = -x, y^0 = -y^0, z = -z$$

At reflecting on the origo, the reflected image of a system of "right-hand" spinning will be of "left-hand" spinning. The right-left symmetry, therefore, means that the physical laws are independent of the choice of a system of co-ordinates.

The spatial reflection is the symmetry of nature because "every" formation has a reflected image, as well. In the mirror, of the right-hand a left-hand helix and of the right hand a left hand helix is formed. The right-hand and left-hand formations — apart from the single property that they cannot cover each other — are equivalent from every point of view.

By the spatial reflection a recent common characteristic of symmetry-principles is shown: symmetry is always connected with the fact that some quantity cannot be measured. We cannot distinguish "right" from "left" because these concepts are connected with each other and are not absolute distinctions like e.g. white and black.

The most strange in the whole is that a microbe can perfectly distinguish the right-hand and left-hand aminoacids and sugars. On the other hand, a researcher would in vain take pains to look for some quantitative signs in the teeth of a man, with which it would be possible to separate those of right hand from those of left hand. It would similarly be a hopeless research task to demonstrate that the quantitative relations, the physical and chemical properties on the right side of the leaves of a tree are different from those on the left side.

2. The main manifestation of evolution, decrease in symmetries and increase in co-ordination

In the development of individuals and species, apart from the spatial organization, the dimension of time is extremely important as well. It is worth while investigating into how the degree of symmetry and arrangement during the onto- and phylogeneses changes.

The decrease in symmetry (violation of symmetry) does not mean a full lack of symmetry but only that the number of available operations causing no change (symmetry-transformation) is lower and lower. It follows from this that the concrete symmetry states show a sequence of development, the most ancient formation being the sphere. The symmetry of highest degree is shown by a homogeneous isotropic body, and its arrangement is close to zero.

2. 1. The most symmetric cell of the living world is the zygote

The zygote has potentially all (geometrical, inner, and isotope-spin) symmetries, (MARÓTI, 1979). The animal zygote has — depending on the quantity of yolk and its localization — more than one type, but they correspond to one another that their shapes are roundish or ovoid.

It is frequent that the distribution of yolk in the zygote is uniform (isolecital). In this case, the first axis of division may be optional, as compared with the longitudinal axis of the zygote, "sphere-symmetrical". If the distribution of yolk is not uniform, then in one yolk a rich (vegetative) and in another a poor (animal) pole will be formed. The first (cylinder—symmetrical) axis of division of the zygotes, like these, corresponds to the animo-vegetative axis.

The second axis of division (furrow) is generally perpendicular to the first axis. The four-celled pro-embryo has a symmetry plane of two equal axes (a bilateral cylindrical symmetry of equal axes).

All cells of the two- or four-celled dividing zygote are almost equivalent. If the cells are separated from one another (polyembryonia), identical twins will be born.

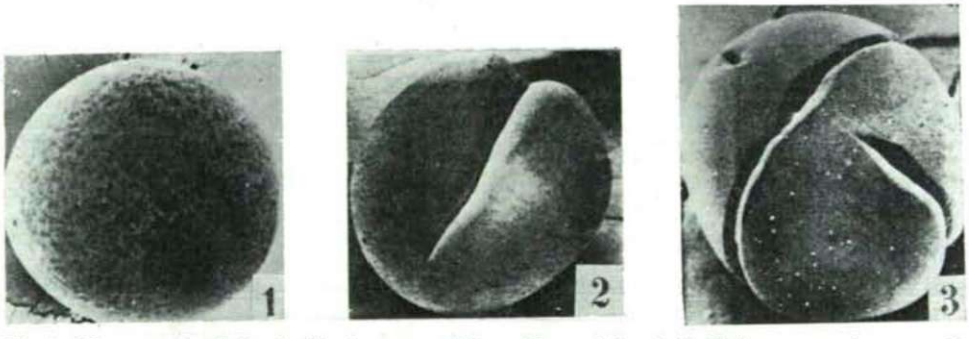


Fig. 1. Merogenesis of the fertilized zygote of frog *(Rana pipiens)*. 1) Unimpregnated ovum; 2) The first cell division in about 2.5hours after the fertilization; 3) The second merogenesis in about1 hour after the first merogenesis. (According to KESSEL & SHIH 1976).

The first divisions of the zygote take place in a rapid succession: the primitive "cell plate", consisting of four cells, will soon be organized into a sphere-symmetrical colony of cells, then into a cell-plate (endoderm). The endoderms of two dimensions take up the form of a sphere, tube and cyst of three dimensions in the course of gastrulation.

The essence of the development of the embryo is the continuous movement in the direction of the decrease in symmetry. At its formation, every cell of the endoderm is of identical value. The migration and three-dimensional arrangement of cells, the formation of the inductive material currents in the right place (in a certain tissue) and in a definite time damage the original (cylindrical and shifting) symmetries. The gastrula gets into a new state of symmetry. Its organizing centre and the foci of the gene will be right and left symmetrical.

2.2. Placing of the heart on the left and right-handedness

YANG (1959) mentioned in his Nobel-report that the physical laws are right and left symmetrical, but in the living world there are considerable differences between right and left sides. "Our heart takes, for instance, place on the left." (Lee and Yang 1956, 1957).

FEYMAN (1969) went even farther and said humorously: If you meet in the cosmic space a space ship arriving from a distant world and the astronaut offers his left hand, you should be careful — he may consist of antimatter!

The possibility is interesting, but we are of the opinion that symmetry should be looked for here, on the Earth, situated this side of the mirror — and not in the anti-man of left hand and right heart.

The heart in human embryo develops from two separate colonies (in the third week of the foetal life). The so-called primitive cardiac tube is symmetrical and takes place in the medial line of the embryo, before the intestinal canal. It has two parts: the venous sinus, the primitive atrium, the primitive heart ventricle, and the arteriectasis.

In the early phase of the embryonal development — similarly to the heart of full-grown fishes — the venous and arterial vascular systems are also symmetrical. Four main (right upper and lower, as well as left upper and lower) veins transport blood into the venous sinus of the cardiac tube. The arterial system also forms initially equivalent aortas on the right and left.

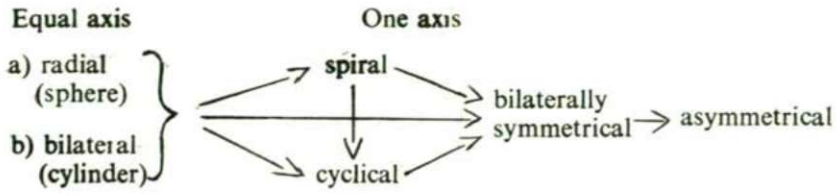
In the course of development, the heart is placed on the left side, and only the left-side main branch of the main aorta survives.

In case of man, we may say of every so-called "asymmetrical" organ that it was originally symmetrical and became asymmetrical only in the course of ontogeny.

Righthandedness is also a result of development. It has supposedly been elicited by the shifting of the heart to the left and by education, as well as doing the work in a standing position.

2.3. Damaging to symmetries in the course of phylogeny

It is shown by countless examples of the living world that phylogeny is also characterized by serial damages of symmetry, by the transition from symmetrical into less symmetrical forms:



The tendency of change in symmetries can be observed in the evolution of families and species of the phyla of Protozoa, Mollusca, Pteridophyta, and Angiospermae, etc.

In the taxonomic tree-like evolution, the trunk of the "tree" symbolizes the changes connecting the (vertical) evolutionary levels (atom, molecule, macro-molecule, prokaryota cell, eukaryota cell, the phyla, classes of Metazoa, etc.). Ant its "horizontally" ramifying branches indicate the unfolding of the given level of organization. In the phylogeny of matter only stable "fermions" of a long living time can take part.

In the course of evolution countless perfect qualities, "inventions" are created but only the forms can get to a higher level of organization that pereserved their symmetry, became less specialized. The "trunk" of the taxonomic tree is more symmetrical than its "branches". The branches are cul-de-sacs, dead-end streets from the point of view of the taxonomic tree-like evolution. Of mammals man is the most symmetrical species.

The damage in symmetry is not frontal, it does not occur by affecting every organ. It can be observed first of all in isolated organs (heart, liver, snail shell, stalk and root of plants, etc.). (MARÓTI, 1969, 1979).

3. Helix symmetries in the living world

The living nature — from Foraminiferae to snails, from phyllotaxes to flowers — is full of always changing and always returning spiral structures. DNA, Watson-Crick's double helix (1957) is the straight continuation of the helix structure of the single-spun protein given by PAULING—COREY (1951). And both are the prominently valuable products of a nearly one thousand years old idea.

The mathematical bases of phyllotaxy go back till FIBONACCI, alias LEONARDO PISANO (1170—1250) mentions the series 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144 ..., any member of which is equal to the sum of the preceding two, in his work, published in 1202, entitled Liber Abaci.

Many interesting mathematical properties of the series have been discovered, but its most important characteristic feature — found about 700 years later — is that it describes the regularity of side-formations in the helix. Apart from the phyllotaxy and flower structures, the regularities of Fibonacci's series are shown by the spiral structure of proteins, as well.

The helix-model proved to be useful particularly in the research of macromolecules but it leaves fundamental problems without response.

On the one hand, it has no adequate explanation for the deeper cause of the formation of the helix symmetries. On the other hand, it is not known, either, why just Fibonacci's series is followed by every helix-like structure.

3.1. The helix is a new stable state of linear formations becoming unstable

A helix can only be covered with itself by the joint application of two transformations (planar turning and shifting along its longitudinal axis). Only the determined combinations of these two operations show a helix symmetry.

Here arises the question, as well, how the helix formations are created.

In our opinion, helix is the manifestation of the cylinder symmetry at a higher level. The condition of equilibrium of the cylinder-symmetrical linear formations becomes unstable as a result of the one-way gravitation (or of another inner or outer parameter), the initial cylinder-symmetry becomes damaged (TÉL, 1979). The new stable state of equilibrium, the helix, has already more stable conditions, and the mutual relation of these conditions corresponds to the original symmetry.

To the spatial self-organization of the "one-dimension" formation, i.e. to the stability of helix, there often contribute some secondary forces, as well.

The cause of the frequent twisting of plants is that they develop in a fixed way in the gravitational field of force. Perpendicularly to the equipotential surface (soil), the gravitational field of force means for them a distinct direction and they grow, therefore, round this fixed direction as round an axis.

As long as the deviation of the shoot apex from the perpendicular axis is small, the state of the cylinder-symmetrical equilibrium survives. But the state of the shoot apex becomes unstable if it, as a result of its inner structure and of the environmental effects, considerably deviates from the perpendicular equilibrium. The shoot apex had initially two symmetry planes but, as a result of shooting, its symmetry decreased. And, as a result of fluctuations and support, the shoot gets into the state of a new stable equilibrium, a helix-symmetric liane stalk is formed.

The direction of twisting takes shape spotaneously but, in the course of the evolution of species the right or left direction may genetically be fixed. It is shown by the genetic analysis of the water snail Limnaea that the direction of twisting is a maternal inheritance (BOYCOTT and DIVER 1923). It seems general that the direction of twisting of the zygote (or meristem) is determined by the polarity of the matrix of the cytoplasm. In the exclusive fixation of some direction the effect of a unidirectional force is important. In case of snail species, the shells of which have no distinct "upper and down" directions, the right-side and left-side shells equally occur. When the tendrils of plants catch at a thing, the right-hand helix became a left-hand one.

3.2. Hidden mirror-symmetry in the phyllotaxis

We may consider as one of the forms of the damage in the cylinder symmetry the helix-like location of the side formations, as well, on the almost cylinder symmetrical stalks.

The leaf arrangements: 1/2, 1/3, 2/5, etc., established on the basis of old observations, are too idealized. In case of alternate phyllotaxes, the leaves above one anot-

her cannot be connected with a straight line. There are no real orthostichons, even the superposed leaves twist slightly, form a helix (spirals).

The helix-like (spiral) arrangement of the side organs can be studied well: on the pine-cones, on the flowers of the fossil angiosperms, on amenta on the position of the fruit of the plants of capitula, etc. BÉRCZI (1976) demonstrated that if we pushed phyllotaxes on the stalks nearer together, we got an arrangement, like in case of pine-cones.

By shrinking the stalk, the symmetry of phyllotaxis may be transformed into cone-symmetry (Table 1).

Table 1

Phyllotaxis	Number of helices twisting to the right and to the left
1/2	1+1
1/3	1+2
2/5	2+3
3/8	3+5
5/13	5+8
8/21	8+13

Phyllotaxes that can be expressed with fractions of higher number than 5/13 can only be observed with difficulty. In inflorescence, however, the number of helices in the flower and fruit is frequent from (8+13) till (89+144).

In the Botanical Garden of the Attila József University in Szeged, we have studied the localization of side organs on a number of plants:

Table 2

Species		Number of helices twisting to right an to left
Juniperus sabina L.	pine-cone	1+1
Picea glauca VASS.	pine cone	3+5
Picea abies (L.) KARST	pine-cone	5+8
Pinus silvestris L.	pine-cone	5+8
Magnolia sp.	fruit	3+5
		5+8
Corylus avellana L.	amentum	5+8
Carya sp.	fruit	8+13
Helianthus annuus L.	inflorescence	34+55 55+89 89+144

In addition, we have observed innumerable other plants, as well, but apart from the 1+1, the number of "spirals", twisting to the right and to the left, agreed in no case in the same "pine-cone." This unambiguously means the lack of mirror symmetry. But where is then the hidden symmetry, established in the title?

If we take a good look at the many hundred pine-cones of the same tree, it turns out that in the half of pine-cones five helices run to the right and eight to the left, and

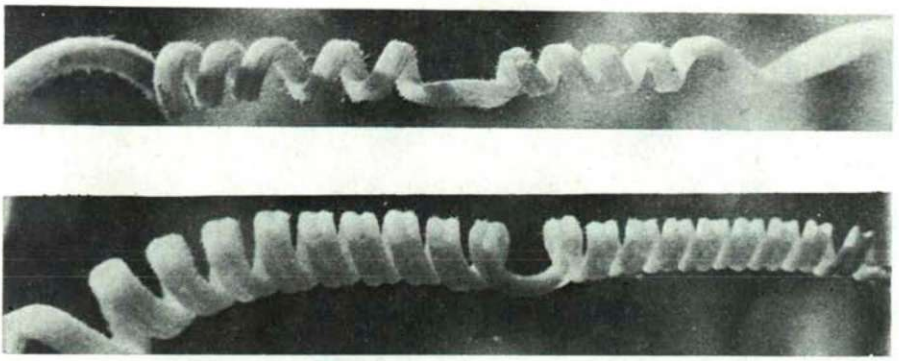


Fig. 2. Branch tendrils of the vegetable marrow *(Cucurbita)*. After clutching, as a result of the power impulses in two directions, the right-hand helix became left hand helix resp. vice versa. (Original).

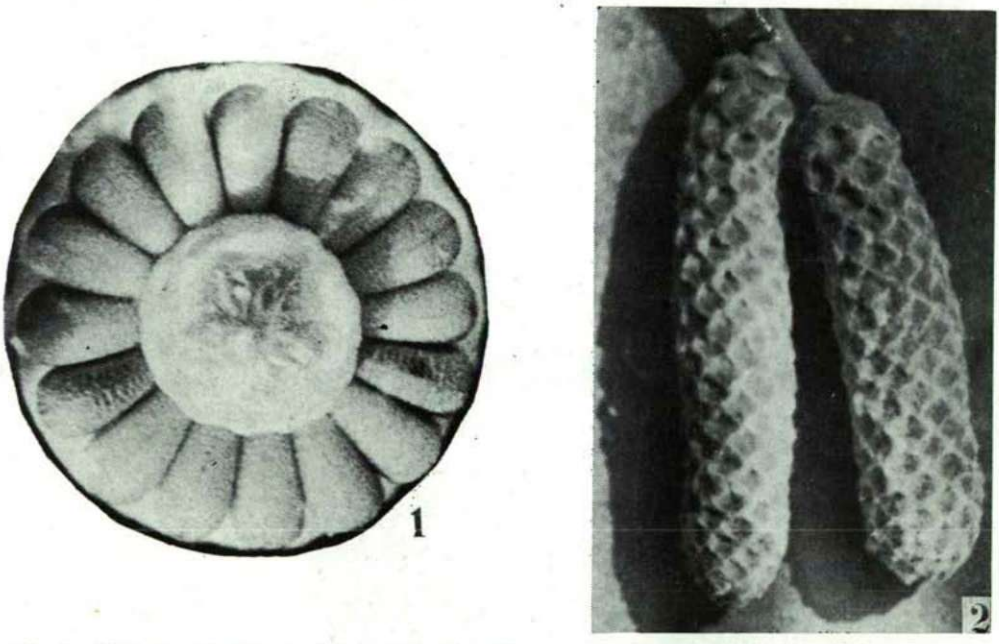


Fig. 3. 1) The "mallow" fruit of the hollyhock *(Atlhaea rosea)*. The capsule is of radial symmetry- and splits up into part-fruits; 2) The hazel *(Corylus avellana)* has mirror symmetric amenta with stamina and 5+8 and 8+5 helices. (Original).

in the other half, five run to the left and eight to the right. At Kiszombor, we have observed approximately 1000 sunflowers (various hybrids), as well, and the symmetry of stocks showed a similar distribution. This is the "wonder" of nature, compensating the damage to symmetry in this way.

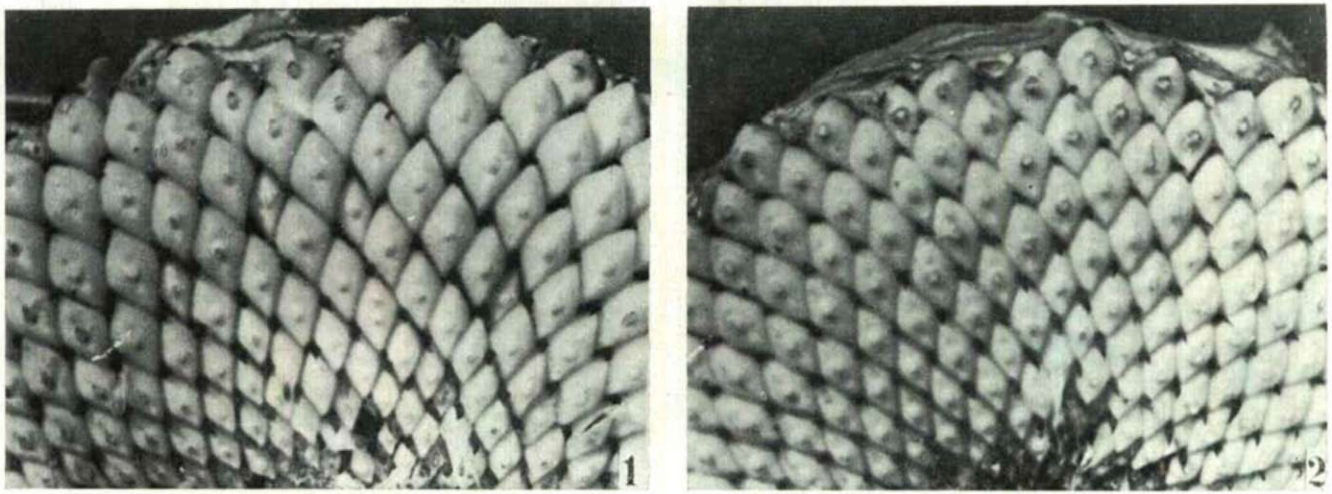


Fig. 4. Arrangement of the uniseed achenia of the sun-floewer on the "plate". 1) There are running 34 helices to the left, 55 helices to the right;
The numbers of fruit-helices are 34 to the right, 55 to the left. The two "plates" originate from one root. The mirror-symmetrical individuals of 89+144 helices are frequent. (Original).

3.3. Why does nature distinguish Fibonacci's numbers?

Helix-symmetries could be satisfied with other arrangements as well. Nevertheless, in nature only leaf arrangements, sporophyll, flower- and fruit-helices occur that can be characterized with Fibonacci's numbers. How does nature select? And what principle is realized in Fibonacci's series?

Before answering the questions, we should outline — according to BÉRCZI (1976) — the arrangement of helices.

We number the megasporophylls in two uniform pine-cones of 3+5 helices. In imagination, we "uncoil" the helices of scales and place them side by side. At first, we present the five helices, running to the left from one of the pine-cones, then the three "helices" running to the right from the other (Fig. 5). For simplification, we draw the forms of scales as rhombi. We get two broad bands. In one of these, the scales form five, in the other three part-bands (helices).

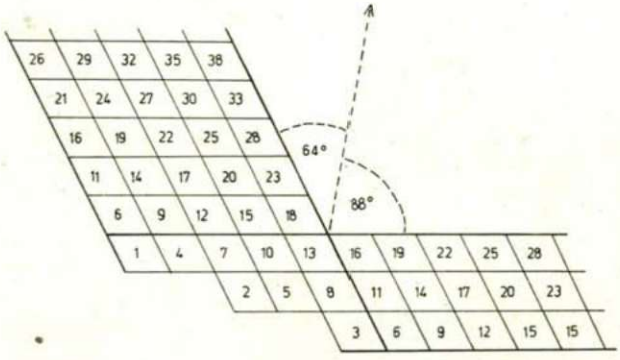


Fig. 5. The outspread picture of a pine-cone of 5+3 helices. Winding up the band of five helices to the left, we obtain the same arrangement as if we had wound up that of three helices to the right.

The two bands are equivalent because at a cylindrical surface the same pine-cone of 5+3 helices could be reproduced by winding up any of the bands. In the band with five helices, with the longitudinal axis of the pine- cone the "part-bands" enclose an angle of about 64 degrees, and in the ribbon with three "helices" an angle of about 88 degrees.

If we draw the "band pair" of the first four members of Fibonacci's series on one another, we may observe the rule of the shifting of helices in the bands of identical breadth (Table 3).

This is the band model of phyllotaxes 1/2, 1/3, 2/5, and 3/8, transformed into pine-cone symmetry, according to BÉRCZI (1976). The helices winding to the right and to the left form two equivalent "bands". The numbers of helices (part-bands), apart from band-pair 1+1, differ from one another. In nature, the reflection-symmetrical pair of every band-pair is also realized.

Table 3

Phyllotaxis	Band pairs								Number of helices winding to the right and to the left
1/2			5 4 3 2 1			5 4 3 2 1			1+1
1/3		8 6 4 2	9 7 5 3 1			5 4 3 2 1			2+1
2/5		6 4 2	9 7 5 3 1			13 10 7 4 1	11 8 5 2	9 6 3	2+3
3/9	19 14 9 4	22 17 12 7 2	25 20 15 10 5	28 23 18 13 8 3	31 26 21 16 11 6 1	19 16 13 10 7 4 1	14 11 8 5 2	9 6 3	5+3

The bands of identical breadth $(\frac{2}{2})$ and $(\frac{3}{3})$, lying over one another, differ from each other to such an extent that in the band of a broader band-pair (1/3 and 3/8) the part-bands are shifted by the distance of a lamella more than in the band of narrower band-pairs (BÉRCZI, 1976).

This shifting can be observed in the bands of identical breadth (helices), lying over each other. In this way, with the shifting operation of the part-bands, known in nature — starting from the simplest band-pair 1+1 — the helix symmetry, characterized by Fibonacci's numbers, can be built up.

By shifting the part-bands, we can build up another helix-symmetrical family of a band-pair of a different starting (e.g., of a helix 4+5). This, however, does not occur in nature because it does not contain the band-pair 1+1. In other words, Fibonacci's series is followed by every helix symmetry in nature bacause this started from the most ancient cylinder symmetry, the arrangement 1+1. In fact, in the ontogeny of plants the damage to the cylinder symmetry of phyllotaxy 1/2 can very often be observed.

The universality of the helix (shifting) symmetry is further deepened in us by the helix structure of protein, as well, which similarly returns to Fibonacci's series (ERNST, 1970).

Recently the spatial arrangement of Watson-Crick's known right-handed DNA double helix was queried by more than one paper CRICK et al. (1979). Of the new

suggestions, the models of FODLEY et al. (1976) and SASISEKHARAN et al (1977, 1978) are entirely symmetrical. In their opinion, the two strands of DNA do not wind round each other but they coil up on opposite sides, on a cylinder-jacket, forming a so-called side-by-side (SBS) structure. Symmetry is also increased that in the strands, sequence parts, winding to the right and to the left, keep alternating.

It is difficult to submit the DNA model to a thorough searching criticism. At any rate, in the anti-parallel directedness of the two strands the restitution of a higher-level symmetry manifests itself. The SBS symmetric structure is, therefore, for us very improbable.

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DETERMINATION OF THE DROUGHT-RESISTANCE OF INBRED MAIZE LINES WITH PROLINE TEST

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Abstract

In our experiment we have started from the understanding that from among the cultivated sorts belonging to the same plant species that is more drought-resistant the leaves of which accumulate more free proline. Water deficiency in the isolated leaves was artificially induced.

1) The proline concentration in the isolated leaves of sixteen sorts of inbred maize lines, owing to water deficiency, ranged from 1 to 6.1 mg. Considering that the difference between the two extreme values is 610 per cent, it is to be established that the degrees of drought-resistance are well-differenciated by proline test. It is shown by our results that more drought-resistant hybrids can be got by cross-fertilizing with each other or with other parent partners some inbred lines that have accumulated, as a result of water deficiency, more proline.

2) In case of water deficiency of leaves, the highest concentrations were given not by proline but by asparagine. At any rate, the asparagine and total amino-acid concentrations of maize lines did not change proportionally with proline quantities.

3) In the isolated leaves, in case of seven inbred lines, a non-protein-forming amino acid, the pipecolic acid appeared but at nine lines it did not. This piperidine-alpha-carbonic acid originates from lysin, in case of a disturbance of protein synthesis.

Introduction

A great majority of the agricultural lands of our country (94 per cent) cannot be irrigated. The study of drought-resistance of the cultivated plants is, therefore, a considerable task. It has already been demonstrated by several researchers that in the soft-stalked plants, in the course of the development of a strong water deficiency, most protein-composing amino acids, particularly proline, very considerably accumulate (BARNETT and NAYLOR, 1966; KUDREV and TJANKOVA, 1966; PÁLFI et al., 1978).

It was also published that the proline content, which considerably increased in the leaves, ensured considerable biochemical advantages for drought-resistance (LEWITT, 1972; BLUM and EBERCON, 1976; PINTÉR et al., 1978).

It was established that the concentration of free proline in the leaves of plants has in every case increased in direct ratio to the degree of increase in water deficiency. The considerable increase in proline is exclusively realized as a result of water deficiency (PÁLFI, 1969).

As the considerable proline accumulation in leaves is connected with essential

advantages in drought-resistence, we suppose that a higher degree of drought-resistance have the sorts that accumulate more proline as a result of a strong soil dryness at the same level. The measurement of proline can, therefore, be used for evaluating drought-resistance (PÁLFI, 1969; PÁLFI and JUHÁSZ 1971).

The linear connection between the level of proline accumulation and the degree of drought-resistance is, as it came to light, the "hereditary character" of the sorts of their hybrids within one species. It is, therefore, possible to determine the degree of the relative drought-resistance of the cultivated sorts belonging to one species — as compared with one another — with the help of the "proline test" (PÁLFI, 1969; PÁLFI and JUHÁSZ, 1971).

We have worked out experimentally on several plants that, in the course of the loss of water, free proline and total amino acid accumulate not only in the leaves of the "intact" plants from the plough-land but also in the excized but surviving leaves. It is important, at any rate, that the strong water deficiency of the isolated and laid-out leaves should develop during the functioning of photo-synthesis. The process inducing the high-level water deficiency has been named live-wilting.

The proline test, elaborated by us (PÁLFI, 1969; PÁLFI and JUHÁSZ, 1971) was first applied in Australia (SINGH et al., 1972), where — owing to water deficiency of the root medium — the highest proline concentration and, with that, the highest drough—resistance was achieved from among ten barley sorts by the so-called "Bánkuti early". The amount of crop, obtained in free field, under dry conditions, was also the largest with this sort.

The aim of this work is, to let known the results of drought-resistance at the inbred maize lines, applying the proline test. Apart from this, we also investigate into the total amount of Cd-ninhydrine positive amino acids, accumulated as a result of the strong loss of water in the isolated leaves, as well as the asparagine concentrations. We study, as well, whether a qualitative difference can be demonstrated in the composition of the free protein- building amino acids of the isolated leaves of the different sorts, as a result of the strong water deficiency.

On the basis of the investigation into 54 soft-stalked plant species, we have ranged the species into two groups: 1) those of "proline type", in the isolated leaves of which the concentration of free proline reaches — as a result of wilting — 10 mg in 1 g dry matter, i.e. 1.0 per cent, or even exceeds that (it may also be 3 to 5 per cent). 2) Those of "non-proline type" are the species in which proline does not reach, as a result of wilting, 10 mg in 1 g dry matter, i.e., it remains below 1.0 per cent (PÁLFI et al., 1978)

Materials and Methods

The preservation and selection of the internationally acknowledged inbred maize lines was carried out in the "Ságvári" Experimental Station of the Cereal Research Institute, Szeged, in agricultural loam. The signs of 16 sorts of inbred maize lines, investigated by us, are given in figures and tables.

The strong loss of water was ensured by the wilting of the isolated leaves, after the first leaves — four of each sort — above the female flowers had been isolated, in the time of 50 per cent female flowering. The total fresh weight of leaf groups was weighed. Then the matter was laid out on trays of known weight and the trays were exposed to illumination for three days in the climate chamber (4000 lux). The temperature of the air medium was regulated between 24—26 °C, the relative vapour content between 60—80 per cent. In the meantime, weighing the leaf groups every 12 hours, we have

directed the tempo of their loss of water so that in three days 80—90 per cent of their water contant should be lost gradually by tanspiration (lethal water deficit) The "wilting weights" obtained thus were recorded. Then the leaves, cut into small pieces, were exsicated at 80 °C and their dry matter was weighed, as well. Finally, after being ground, the matter was well-condensed and hermetically closed in small vessels.

For the purpose of amino-acid analyses, from 200 mg of the pulverized leaves an extract was made. Homogenization was carried out with 1.0 g quartz sand and 20.0 ml 40 p.c. ethanol. After purification, the original amino-acid extracts were dry distilled, on water bath. Then the amino--acids were again solved in 40 per cent ethanol, being only one-quarter volume as compared with the original amount, that is to say, the analyses were carried out from 4 times concentrated extracts.

Proline was measured according to Chinar's (1952), the total amino acid according to Rosen's method (1957), as modified eluation-colorimetrically. The demonstration of asparagine and the detailed processes were already described (PÁLFI et al., 1978).

The average results of the fourfold repetition of analyses are published. If the difference of a measurement from the mean (deviation) exceeded ± 5 per cent, the whole part analysis was repeated.

Results and their evaluation

The leaf samples of the studied 16 sorts of inbred lines were taken and elaborated in two groups of eight. In Table I, we have given the quantitative data of proline, asparagine and total amino acids of the inbred lines ranged into the first group of eight

In Table 1 we can see an "extremely high" proline concentration, produced by the line of sign V 12. In the course of our investigations carried out mainly with hybrids, such a high proline content has not been demonstrated as yet (PINTÉR et al., 1977, 1978; PÁLFI et al., 1978). Expressing our data published in mg/1 g dry matter in the percentage of the dry matter, we obtain 0.61 per cent. It is to be established that even the highest quantity is considerably below 1 per cent proline concentration, which is characteristic of the species of the "proline type".

In Table 1, we have not found any line below 6.1 meg proline content, reaching either 5 or 4 or 3 mg. The next highest proline (2.6 mg) was given by line V 41. And the lowest proline content (1.1 mg) belonged to No. V 5. At the same time, three more lines (V 46, V 14, V 24) can be ranged into the (comparatively low) interval between 1.0 and 2.0 mg. Between 2 and 3 mg, take similarly place 3 lines (V 18, V 17, V 41). These are forming the "medium" proline level.

It appears in Table 1 that, as a result of the strong loss of water of leaves, from among the amino acids and their amides asparagine has reached the highest concentration (maize is no species of proline type!). The amount of asparagine approached in several cases even half of the total amino-acid concentration of Cd-ninhydrine positive (V 5), or it reached (V 41) or even exceeded this (V 12). At five sorts of lines, the asparagine content exceeded even the largest proline quantity, i.e., 6.1 mg. If we compare the asparagine concentrations of the single lines with their own proline quantities, we twice obtain identical concentrations, in cases of the other six sorts of lines, the asparagine content considerably exceeds the proline quantities. At the single lines, however, the proline and asparagine concentrations change, as a result of the loss of water, not parallel, i.e., not in direct ratio.

In case of the total amino-acid contents of Cd — ninhidrine positive ih Table 1, it turned out, as well, that — like in case of asparagine — the larger quantities do not always coincide with the larger and largest proline concentrations. We cannot

draw, therefore, any conclusion from these data in respect to the determination of drought-resistance.

Investigating into the qualitative composition of the "protein-composing amino acids", we have established that there is no difference between the lines.

The "non-protein-composing pipecolic acid" was, however, present in the extract of seven lines; in nine of these, on the other hand, it was not present.

About the appearance of pipecolic acid in the leaf tissues it was published by Diener and Decker (1954) that it takes place in the older leaves of peach in case of the infection by "Western X" virus in a considerable quantity. This was later demonstr ated by BOZARTH and DIENER (1963) about other plants, as well, suffering from other virus diseases. YATSU and BOYNTON (1959) demonstrated pipecolic acid as a result of treating strawberry with agents inhibiting protein synthesis and growth. SEHGAL and BOONE (1964) found no pipecolic acid in the leaf of normal strawberry plants but they found that in those fertilized with "Multiplier" disease.

Pipecolic acid, consisting of piperidine rings, carboxylyzed in alpha position, was first demonstrated in our country from the leaves of rice plants (PÁLFI, 1967, 1968). Mainly at the flowering of rice, in a gloomy-rainy weather, resp. in the time of a strong fall in temperature. These external conditions predispose rice to diseases. According to the data of the author, pipecolic acid results from lysin in the leaves of infected tobacco, potato and wheat plants (PÁLFI, 1967, 1968; PÁLFI and JUHÁSZ 1969) established in case of the investigated species (wheat, rye, barley, rice, maize) of the Gramineae family that pipecolic acid is the production of a disturbed protein synthesis, in case of damaging external conditions. like mainly an infection, strong loss of water, salty-alkali soil, unfavourable high or low temperature, etc. MCDONALD (1974) investigated normal potato tubers and those infected with leaf-roll viruses and always found pipecolic acid only in infected tubers. In his opinion, pipecolic acid appears as a result of the inhibited growth and the protein synthesis, disturbed by the disease.

In case of maize, the cause of the origin of pipecolic acid is not cleared up, as yet. The artificial (enforced!) self-pollination has, as it is known, an inhibitive effect on protein synthesis, resp., growth. The shoots of the inbred lines reach, namely, generally only 120—140 cm height. It may be supposed that the appearance of pipeeolic acid is elicited, at some sorts, by self-pollinations.

We may think as well, that in the time of a strong pollen fall at female flowering a large amount of pollen accumulates generally in the axils of leaves below the tassel. The large mass of pollen with rough surface induces the physical lesion of leaf sheaths, the penetration of the spores of fungi and promote infections in this way. At the same time, the fast disintegrated pollen may be considered as a very good, increasing culture medium. This phenomenon can be regarded as one of the original causes of the infections by "Fusarium" species, inducing the putrefaction of the stalk, which may be connected with the appearance of pipecolic acid.

NAIK and BUSCH (1978) demonstrated that the infection of *Fusarium graminearum* is stimulated by the maize pollen. According to the authors, the dark lesions found in the leaf sheaths are induced by the deposited anthera and pollen. Starting on this track, the authors have proved that the germination of conidia is characteristically increased by pollen dialyzates. At the same time, dextrose and saccharose, as culture media — without any pollen dialysate — have only resulted in an infection in case of using the highest concentration of conidium suspension (an artificial infect-

Table 1. The Cd-ninhydrine positive total amino acid, asparagine (Asn) and proline (Pro) concentration of the isolated leaves of eight sorts of inbred maize lines, in the ratio of mg/l g dry matter- as well as the sum of these, in case of a strong water deficiency. As samples, the first leaves above the female flowers were taken. The average results of the repetitions of analyses are published. The deviations of the single repetitions from the average results (dispersion) do not exceed ±5 per cent. The data published in the mg/l g dry matter divided by ten, the results are obtained in the percentage of the dry matter.

Signs of the inbred maize lines	Cd-ninhydrine positive amino acids	Asparagine (ASN)	Proline (PRO)	Together: ASN+PRO+ +Cd-ninhydrin positive amino acids
	mg/l g dry matter			
V 5	23.1	10.4	1.1	34.6
V 12	27.0	15.2	6.1	48.3
V 18	23,1	8.0	2.5	33.6
V 46	32.7	9.6	2.0	44.3
V 14	15.2	1.6	1.6	18.4
V 17	16.0	3.2	2.2	21.4
V 24	15.2	1.6	1.6	18.4
V 41	24.0	12.0	2.6	38.6

ing agent). At this phenomenon, it is also to be taken into consideration, if the upper leaves of the stalk — as compared with the stalk itself — belong to the standing-up type. In this case, namely, a larger amount of pollen can accumulate in the leaf sheaths, for which the chance of being fertilized can increase, as well.

The quantitative data of proline, asparagine and total amino acids of the eight sorts of maize lines, taken in the second time, are given in Table 2.

It is shown by Table 2 that the asparagine concentrations are generally higher than those of the eight sorts of the earlier ripening inbred sorts in Table I. It can also be established that the degree of the asparagine content is not connected either in direct or in inverse ratio with the proline quantities of sorts.

The Cd-ninhydrine positive, protein-forming, total amino-acid contents of the maize lines, shown in Table 2, are generally also larger than the quantities in Table 1. At the same time, the interval of results is straiter. It is to be seen that there is shown no correlation with the proline concentration of lines either by the total sums of asparagines or by those of total amino acids, amino acids or amids. It is, therefore, necessary to evaluate the proline contents separately.

In Table 2, four lines achieved a proline concentration above 3, resp. 4 mg. Although the highest proline quantity was achieved at a line in Table 1, the inbred lines of Table 2 finally gave, nevertheless, higher total proline results.

In ultimate analysis, from among the 16 lines, published in Tables 1 and 2, the "high-level" drought-resistance, determined on the basis of the proline content (higher than 3 mg proline) was demonstrated in five inbred lines. For making a comparison, we mention that in the last two years we carried out an wilting proline test with 12 sorts of hybrid maize which proved good in public cultivation, as well (PINTÉR et al., 1977, 1978; PÁLFI et al., 1978), and a high-level drought-resistance was only achieved with a single hybrid (KSC 360, improved by JÁNOS NÉMETH).

Table 2. The Cd-ninhydrine positive total amino acid, asparagine and proline concentration of the isolated leaves of eight sorts of inbred maize lines investigated in group 2, as well as the sum of these, in case of a strong water-deficiency. The average results of the repetitions of the single repetitions from the average results (dispersion) do not exceed ±5 per cent.

Signs of the inbred maize lines	Cd-ninhydrine positive amino acids	Asparagine (ASN)	Proline (PRO)	Together: ASN+PRO+ Cd-ninhydrine positive amino acids
	mg/1g dry matter			
V 2	27.0	16.8	1.7	45.5
V 3	21.9	9.2	3.7	34.8
V 4	24.6	3.2	4.8	32.6
V 15	23.1	10.0	4.3	37.4
V 27	25.8	7.2	1.0	34.0
V 28	23.1	10.4	3.6	37.1
V 31	33.5	15.2	2.9	51.6
V 32	30.6	10.4	2.5	43.5

A proline concentration above 4 mg was not shown, at the same time, by any of the hybrids.

Taking into consideration that we have demonstrated in our present experiment among the investigated lines some sorts having a considerably higher drought-resistant faculty, as compared with the hybrids, after further investigations, resp. selection, the breeding of better drought-resistant hybrids can also be realized by the systematic cross-fertilization of the inbred lines of higher proline content.

The recent distribution of the proline test of drought-resistance is also worth studying.

In the United States, BLUM and EBERCON (1976) have established in the course of a strong water deficiency of eight sorts of broomcorn that the quantity of the free proline accumulated in leaves is connected with the degree of drought-resistance and this phenomenon is a phenomenon of "genotypical" regularity.

MALI and MEHTA (1977) investigated the drought-tolerance of two rice sorts, similarly on the basis of the proline accumulation in the course of water-deficiency. They have demonstrated in a medium of −10 bar osmotic pressure, in the more drought-resistant sort a 5.4 - fold increase in the proline concentration but in the sort which was more sensitive to drought-deficiency, only a 1.2-fold concentration. The authors tried to select rice-sorts of lower water-demand for the so-called "dry-cultivating" rice production.

SRINIVASA (1977) established on saft-stalked plants belonging to dicotyledons that the quantity of free proline grew in the leaf of every "genotype", as a result of water stress, proportionately to the degree of drought-tolerance. SASHIDBAR (1977) carried out drought-resistance tests on ten sorts of ground-nuts, on the basis of the proline test. He has demonstrated that, as a result of a strong water deficiency of uniform level, the droughtresistant forms accumulate considerably more proline than those being more sentivive to water-deficiency and that this character of the sorts is "genotypic".

The theory and practical effectuation of the proline test of drought-resistance was first elaborated and published in our country (PÁLFI, 1969; PÁLFI & JUHÁSZ, 1971). The proline test — in fact, by different varieties of inducing water-deficiency — has since then been spreading all over the world. At the same time, it is to be mentioned that the proline test was first applied in the practical plant-improving work, on ten sorts of barley, by SINGH et al (1972), on maize by PINTÉR et al. (1977), and on rye and yellow lupine by PÁLFI et al. (1978).

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ATPase ACTIVITY AND ITS CONNECTION WITH THE ACTIVE K^+ UPTAKE OF DIFFERENT SEGMENTS OF RICE AND WHEAT ROOTS

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Summary

Microsomal ATPase activity of different segments of a thermophilic plant rice (*Oryza sativa* L. cv. Dunghan Shali) and a non-thermophilic plant wheat (*Triticum aestivum* L. cv. Rannaja-12) were investigated. Seedlings were grown in water culture (5×10^{-4}M $CaSO_4$ solution) under controlled conditions. ATPase activities of both plants were similar and could be activated by adding 5×10^{-4}M KCl and 5×10^{-4}M $CaCl_2$, but there were differences between the ATPase pattern of the species along the primary roots. In the case of rice, there were large enzyme activities in the elongation zone, while regarding the wheat a determined peak could be measured at the third segment from the root tip. ATPase activities of the first and the last portions (4—5 cm) as well as those of the second and the fourth zones were similar. Our results agree with earlier data on the K^+ uptake and of the K^+ content experiments.

Introduction

In our preliminary studies some enzymkinetic parameters of rice root (e. g. optimum protein content, ATP concentration, ion strenght, pH) were determined (TÓTH, 1976). Later similar measurements were done using ATPase enzyme of wheat roots, too. Our results which correspond to the literature data prove the important role of ATPase enzyme in active ion uptake processes of plants (CHRISTIANSEN and LINDBERG, 1976; LEIGHT and WYN JONES, 1976; KUIPER et al, 1974). There is a strong correlative evidence relating to K^+ uptake to K^+ stimulating effect of the microsomal ATPase of oat root (BALKE and HODGES, 1975). In the case of maize LEONARD and HOTCHKISS (1976) reported similar result, and using wheat root KYLIN and KHÄR (1976) demonstrated this evidence.

Recently, the connection between the active cation uptake and cation activated ATPases can be considered as a proof. It is remarkable that almost in all cases these investigations had been done with roots of different length but intact. Earlier studies, however, indicated non-equal participation of the different zones of the primary roots of rice and wheat in the K^+ uptake and significant differences could be measured in the K^+ content of the individual segments, too. (ZSOLDOS and KARVALY, 1978). Furthermore, there are variances among different species in respect of ion uptake and the anomalous high K^+ uptake of thermophilic plants at low temperature may be explained by this.

In the present work the main aim was to examine the microsomal ATPase activity and activation of each segment along the primary roots. The last question is very interesting because in our earlier studies the (Ca^{2+}, K^+) ATPase activity seemed to be under genetic control and appears only on a determined level of the organisation (ERDEI et al, 1977). The first, 4—5 mm long segment of the primary root (division zone) corresponds to the lower level of organisation, while the more distant portions from the root tip (elongation, absorption zones) can be considered to be of higher organisational status.

Our present work is considered to be a preliminary study of a series of investigations in which transport features, hormone sensitivity of different segments of roots will be investigated.

Materials and Methods

In our experiments with ATPase activity of 1 cm portion of roots of rice and wheat were investigated in parallel. Seedlings were grown under standard conditions, in low salt (5×10^{-4}M $CaSO_4$) solution, determined light, and humidity, as described earlier (ERDEI at al, 1977). The plants used in the experiments were 5—7 days old, their roots being about 6—7 cm long. The roots were washed three times in destilled water then cut to 1 cm long segments. Preparation of microsomal fraction (10.000—30.000 g) was as described earlier, too, using an extraction medium containing 250 mM suchrose, 25 mM Tris-HCl buffer and 3 mM EDTA, pH value was 6.9 in the case of rice and 7.5 using wheat plant, respectively.

The determination of ATPase activity was done using a reaction system having 1 ml total volume which contained 100—200 μg protein, 5 mM ATP, 5 mM KCl, 0,5 mM $CaCl_2$ and 20 mM Tris-HCl buffer (pH 6.9 and 7.5 respectively). The reaction was started by addition of ATP run for 10 minutes at 32 °C and stopped with ice cold 40% TCA. The specific activity of enzyme was calculated as μmole P_i released by 1 mg protein per hour. The classical FISKE and SUBBAROW method (1925) was used for the determination of P_i and the protein was assayed according to the LOWRY method (1951). All experiments were made on triplicate, sometimes five times, and the error was about 5%.

Results and Discussion

Figures 1. and 2. show the ATPase activity of different segments of rice and wheat roots. From the data it is visible that the activities are in the same order. KYLIN and KHÄR (1974) reported similar results using wheat roots. To compare the two Figures with each other the relative low enzyme activity of the first and the last segments can be established. This almost equal correspondence is very interesting since the first segment contains mostly rapidly dividing cells having minimum vacuola, while in the last zone the vessels have already appeared and a determined state of root hair can be detected. In the case of rice the ATPase activity between the 2—5 segments is almost similar and it is interesting enough that it is 80% more than the activities of the first and the last portions. As regards the wheat, a significant peak can be detected in the third zone which activity is also 80% more than in the first, while 68% higher than at the second and the fourth segments.

Differences in the ATPase pattern of the two species may be ascribed to differences which are in the morphological, tissue and cell levels of roots of the thermophilic and non-thermophilic plants (ZSOLDOS and GULYÁS, 1979). Data measured at the wheat completely equal the K^+uptake pattern of different segment at 25 °C, since the K^+ content at the third segments is a manifold of the amount of the first and the last portions (ZSOLDOS and KARVALY, 1978). In the case of rice a gradual rise

can be seen in the K^+ uptake, there are higher amounts at the more mature segments of root. The first segments of both plants have the lowest K^+ uptake.

Comparing the results to data of content of different segments another interesting connection can be observed (ZSOLDOS and KARVALY, 1978). The more differentiated segments of both plants show decreasing levels, the first zones having significantly more K^+ content. As regards the (Ca^{2+},K^+) ATPase patterns, the K^+ uptake curves and the K^+ content distributions there may be a strong evidence that the uptake is connected with the function of transport enzyme. This connected process is most determined in the elongation zone, while the first segment has only a small role in the ion uptake process of root.

From the data above it seems that the different segments of various plants show important unequal features in the transport processes. Our earlier studies indicated that the K^+ uptake and the (Ca^{2+}, K^+) ATPase activity is under hormonal control (ERDEI et al, 1979). So it may be a very interesting question to investigate the hormone and the herbicide sensitivity of different segments of roots.

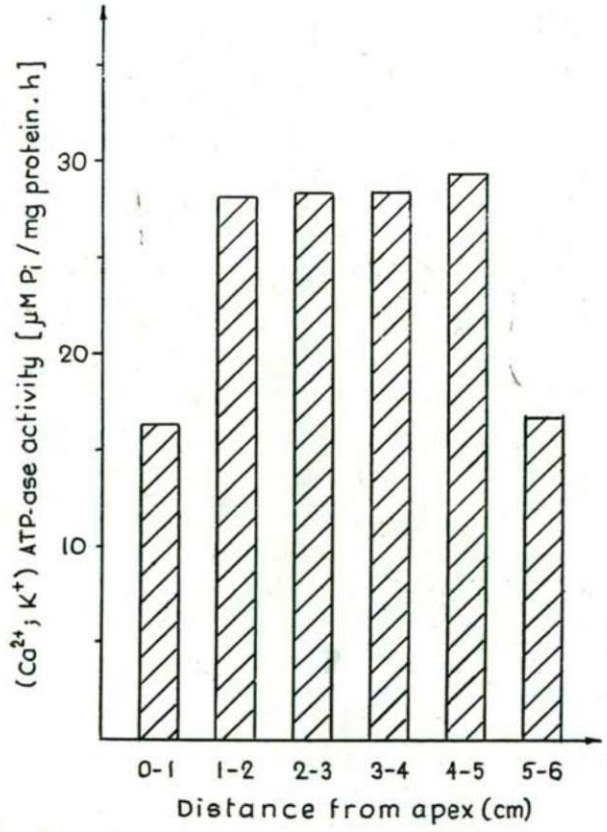

Fig. 1. Microsomal ATPase activity of different segments of rice along the primary roots.

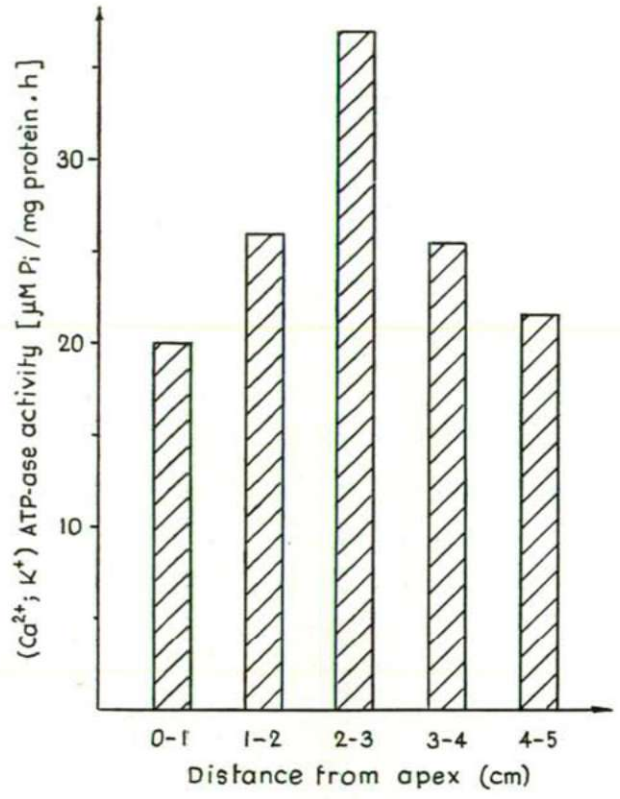

Fig. 2. Microsomal ATPase activity of different segments of wheat along the primary roots.

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EFFECT OF 2,4—D AND OF OIL-POLLUTED WATER ON THE GROWTH AND THE METABOLIC PROCESSES OF CUCURBITACEAE SEEDLINGS

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Abstract

"Dikonirt", the 2.4-D sodium salt, portioned into the soil preemergently, had a toxic effect on Cucurbitaceae seedlings for 23 days. The damaging effect of the herbicide could be demonstrated, in a more and more decreasing degree, for about 50 days. After that, it did not induce any trouble in the growth and metabolism of plants.

The oil-polluted water, applied for watering preemergently, checked the growth of seedlings and the accumulation of dry matter but it did not destroy them. The oilcontaining water, applied for watering postemergently, had a toxic effect, shown well by the investigated indices of metabolism.

Introduction

In previous works (HORVÁTH—TAN VAN LE, 1976; HORVÁTH—KERESZTES, 1977) we investigated into the herbicide effect of "Dikonirt", an agent containing 2.4-D in different concentrations, exerted on cultivated plants and aquatic vegetation. We have observed that it the plants get more of the agent than the permitted concentration, they are damaged in different degrees. The degree of damage can be followed by the help of certain metabolism indices, as well as of the structural and numerical changes in chromosomes.

In this publication we are investigating into how long 2.4-D preserves its effect in the soil to such an extent that it still damages the cultivated plants. Apart from we are also investigating into the effect of engine-oil, got into the water, on plants watered pre- and postemergently. In these experiments we started from the fact that the water of the Tisza, serving for irrigation, from time to time contains 10 mg/l engine-oil as well (HORVÁTH—BALOGH, 1979).

Materials and Methods

Our experimental plant was the yellow flowered gourd, (Cucurbita pepo L. of the "tapering" sort). The plants were cultivated in the soil. The herbicide "Dikonirt" of 0.5 ad 1 g 2.4-D agent per cultivating vessel was, given in the time of sowing; i.e., we have applied a preemergent treatment, The 2.4-D-treated and the control plants were watered with tap water and, of course, raised in light. at a temperature of 25 °C. When investigating the use of tap water, polluted with engine-oil, for watering, we have also worked with Cucurbitaceae seedlings. For making watering, tap water, 10 and 30 mg engine-oil was given to 1 litre running tap water; as a control, clean tap water was used. At a

preemergent treatment, the Cucurbitaceae seeds were germinated on a filter-paper, sopped with oiled water, in a Petri dish, in a thermostat of 23 °C. The laboratory investigations were performed on the fifth or sixth day of germination. At the postemergent treatment, 3—4 days old seedlings were placed into the tap water, polluted with two kinds of motor-engine and the plants were raised in a light-thermostat (7000 lux).

The growth and the accumulation of dry matter were measured in both experimental series as a function of time.

Changes in metabolism were measured on the basis of a few indices. The quantity of the total soluble protein was determined with the method of LOWRY et al. (1951), the quantity of ascorbic acid by means of dichlorophenol-indophenol, the activity of peroxidase with the method of COLOWICK-KAPLAN (1955).

Results and Discussion

1) Effect of 2.4-D on Cucurbitaceae seedlings

Cucurbitaceae seedlings, treated with 2.4-D preemergently, were investigated [23 days old] and compared with controls. We have observed that a considerable damage was induced by the herbicide. Growth was strongly checked by 2.4-D, administered in a higher concentration, so that only 1 to 2 cm long, degenerate, chapped shoots developed. On the other hand, the lengthening of shoots was less reduced by chemicals of lower concentration.

After digging up the plants, there was not administered any herbicide into the soil of culture-vessels but gourd seeds were again planted into them in order to investigate the persistence of 2.4-D. Plants were again processed, 23-day old. Then we planted seeds for the third time into the culture-vessels and investigated and examined the plants sprouted from these, 18-day old. The formation of the dry matter content is summarized in Table 1.

At first planting, the stronger 2.4-D concentration resulted in deformed shoots of reduced growth in which the dry matter content was nearly the quadruple of that in the control. The lower herbicide concentration has checked the growth of shoots but in a lower degree, and resulted about twice as much dry matter accumulation as observed in the control.

In case of the second planting, the effect of 2.4-D was mostly eliminated because in the growth of the 23-day old plants only a little difference appeared, and the accumulation of dry matter was approximately identical with that in the control.

Plants from the third planting were processed 18-day old, i. e., on the 64th day after putting 2.4-D in the soil. In case of these plants no difference in growth was ob-

Table 1. Formation of the dry matter content in Cucurbitaceae seedlings, treated with 2.4-D preemergently (mg/g fresh weight).

2.4-D amount in the culture-vessel	Planting 1	Planting 2	Planting 3
	age of the plant in days		
	23	23	18
1 g	197	51	48
0.5g	100	47	42
0 g, control	51	44	48

served as compared with the control. The little difference in the dry matter content was also within the limits of standard deviation.

In our experiments, the plants treated with 2.4-D preemergently were, therefore, under the toxic effect of the herbicide for 23 days. In case of the seedlings of the second planting, hardly any damaging effect of the herbicide has appeared, although their growth was not equalized, as yet. The plants of the third planting already agree with controls both in their growth and in the dry matter content.

As an index of metabolism, the activity of peroxidase enzyme was measured in the 23-day old plants, preemergently treated with 2.4-D and coming from the first planting, as well as in controls (Table 2). According to the data, as a result of both 2.4-D concentrations, the peroxidase activity in shoots strikingly increased, which is referring to serious disorders of metabolism. The poisonous perishing of plants and the time-span of the toxic effect of the herbicide are indicated by the increased peroxidase activity as well.

Our observations were also supported by the formation of the ascorbic acid (AA) amount in shoots (Table 3). In the considerably damaged plants, from the culture-vessels containing 1 g herbicide, a large quantity of ascorbic acid can be measured, which refers to abnormally increased oxi-reductive processes. The ascorbic acid content increases already as a result of the 0.5 g herbicide but to a lower extent, which corresponds to a minor growth retardation and damaging.

Table 2. Peroxidase activity in Cucurbitaceae seedlings, treated preemergently and not-treated with 2.4-D (23rd day).

2.4- D content in the culture-vessels	Enzyme-units
1 g	150
0.5 g	131
0 g, control	69

Table 3. Quantity of ascorbic acid in Cucurbitaceae seedlings, treated preemergently and not-treated with 2.4-D (23rd day).

Treatments:	1 g 2.4-D	0.5 g 2.4-D	control
AA µg/g fresh weight:	180	130	95

We could, therefore, establish in our cultur-vessel experiments that the toxic effect of 2.4-D gets on for 23 days after being put in the soil. On the plants of the second sowing in the same soil (46th day), the herbicide effect can hardly be demonstrated and is hardly visible; and the plants of the third sowing (64th day) are equal to controls. 2.4-D preserves, therefore, its effect damaging the cultivated plant in the soil for about fifty days.

2) Effect of watering with oil-polluted water on Cucurbitaceae seedlings

The growth of Cucurbitaceae seedlings germinated in tap water of 10 mg/l and 30 mg/l oil concentration and in pure tap water is shown in Table 4, and their dry matter content in Table 5. According to the data, the water polluted by both

Table 4. Shoot and root growth of 6-day old Cucurbitaceae seedlings, treated preemergently with oil-polluted water.

Treatments	Shoot-length mm	Root-length mm
30 mg oil/l water	42	46
10 mg oil/1 water	49	57
tap-water control	56	75

Table 5. Dry matter content of 6-day old Cucurbitaceae seedlings, treated preemergently with oil-polluted water, (mg/g fresh weight)

Treatments	Shoot	Root
30 mg oil/1 water	41	58
10 mg oil/1 water	48	105
tap-water control	48	181

oil amounts considerably checks the growth of shoots and roots in seedlings, as well as the dry matter production. But the plants have not perished.

The ascorbic acid content of the Cucurbitaceae seedlings raised in oily water increases parallel with the quantity of oil (Table 6), which — as seen in the case of 2.4-D, as well — shows the irregularity of metabolism. The amount of ascorbic acid increases parallel with the degree of checking the grow.

Table 6. Ascorbic acid contcnt of Cucurbitaceae seedlings, treated preemergently with oil-polluted water, (μg/g fresh weight).

Treatments	Shoot		Root	
	5 days	6 days	5 days	6 days
30 mg oil/1 water	252	147	213	200
10 mg oil/1 water	195	145	175	188
tap-water control	158	139	125	185

The peroxidase activity of seedlings was not considerably affected by the preemergently applied oily water (Table 7).

In case of the postemergent application of the oil-polluted water, we have determined the total soluble amount (Table 8) and the peroxidase activity (Table 9) in the seedlings of Cucurbitaceae.

As it is to be seen, the total protein content increased, parallel with the degree of growth retardation and damaging by oil-pollution. The plants perished as a result of both oil concentrations.

Table 7. Peroxidase activity in 6-day old Cucurbitaceae seedlings, treated preemergently with oil-polluted water.

Treatments	Enzyme units in	
	Shoot	Root
30 mg oil/1 water	100	110
10 mg oil mg/1 water	104	105
tap-water control	98	103

Table 8. Quantity of total soluble protein in the shoots of Cucurbicaceae seedlings, treated postemergently with oily water.

Treatments	The age of plants in days		
	6	15	20
30 mg oil/1 water	499	594	855
10 mg oil/1 water	473	528	735
tap-water control	415	471	459

Table 9. Peroxidase activity in the shoots of Cucurbitaceae seedlings, treated postemergently with oily water (In enyme units).

Treatments	The age of plants in days					
	5	6	8	10	15	16
10 mg oil/1 water	110	101	113	116	116	perished
10 mg oil/1 water	97	95	113	117	108	119
tap-water control	71	73	74	75	88	85

By the increase in the activity of peroxidase the pathological changes in the metabolism of plants were similarly indicated, quasi predicting the perishing of plants to be expected as a result of the emergently applied two kinds of oil concentration.

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DISPERSION OF HIGH DENSITY ANT POPULATIONS IN SANDY SOIL GRASSLAND ECOSYSTEMS

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Abstract

Dispersion of five ant populations was analysed on two grasslands, *Potentillo-Festucetum pseudovinae* and *Cynodonti-Poëtum angustifoliae* in Kiskunság National Park, Hungary. In contradiction to the results of estimating methods it was proved by Pielou's method being very useful for ant populations that in the case of the populations investigated the unit value of $s^2/\bar{x}$ doesn't mean a random dispersion.

Introduction

Many ecologists agree that the dispersion is one of the most important characteristics of the population-space relation. While density means the quantitative aspect of this relation, i.e. how many individuals or in the case of ants how many calies are in a unit of space, dispersion is a qualitative characteristic and it gives a lot of important information on populations such as presence or absence of competition within populations; ethological conditions of populations; homogeneity of environment; changes taking place in the environment etc. The knowledge of dispersion type is essential from the point of view of sampling method, as well.

Several methods were published for describing and identifying types of dispersion. BALOGH (1953) distinguished six types on the grounds of homogeneity of distribution and the size of animals. He numerically marked the homogeneity of dispersion by the "index of homogeneity":

$$H = \frac{n}{\sum x_i} \cdot 100 \qquad (1)$$

where n is the number of samples; x the total number of individuals. The only condition of the application of this index is that samples should be as large as the minimiareal of population.

SCHWERDTFEGER (1968) distinguishes linear, horizontal, vertical and spatial dispersions. In practice only the horizontal types are used. Schwerdtfeger's horizontal dispersion types are: äqual, inäqual, cumular and insular. Analysing the types of dispersion the third and fourth types (cumular and insular) are usually drawn together, as two states of a cumular tendency and so three of dispersion types are used: (1) uniform (=äqual); (2) clumping (=cumular+insular) and (3) random (=inäqual).

For identifying the types the following methods are generally used:

(1) Index of dispersion:

$$V = \frac{s^2}{\bar{x}} \tag{2}$$

where s^2 is the variance of samples; $\bar{x}$ average density per sample. The theoretical basis of this index is that the variance of Poisson distribution regarded as a mathematical model of random dispersion is equal to mean, so if $V=1$ the dispersion is random, if $V>1$, clumping and if $V<1$, uniform.

(2) χ^2 test of the index V:

$$\chi^2 = \frac{s^2}{\bar{x}}(N-1) \tag{3}$$

where N is the number of samples (SOUTHWOOD, 1966). The basis of this method is that the form of the index of dispersion

$$V = \frac{\sum(\bar{x}_i-\bar{x})^2}{\sum x_i}$$

and the form of $\varkappa^2$ test

$$\varkappa^2 = \frac{(E_i-o_i)^2}{E_i} \tag{4}$$

are similar and so V index presumably follows $\varkappa^2$ distribution.

(3) The "mean crowding" suggested by LLOYD (1967) is one of the important characteristics of populations:

$$\overset{*}{x} = \frac{\sum x_i(x_i-1)}{\sum x_i} = \frac{\sum x_i^2}{\sum x_i} - 1 \tag{5}$$

Replacing this with the formulae of variance and mean:

$$\overset{*}{x} = \bar{x} + \frac{s^2}{\bar{x}} - 1 \tag{6}$$

On this basis Lloyd (1967) suggested the ratio $\overset{*}{x}/\bar{x}$, so called patchiness, to be a measure of dispersion.

(4) Fitting to the Poisson distribution by $\varkappa^2$ test basing on the samples taken (ANDREWARTHA, 1961, GALLÉ, 1973). If the result of this test isn't positive significantly, the type of dispersion of the population is identified from the value of index V or fitting tests to positive or negative bionomial distributions.

(5) The "k" of negative bionomial

$$k = \frac{\bar{x}^2}{s^2-\bar{x}} \tag{7}$$

is used as a measure of aggregation of clumping dispersion, but its limits have recently been shown by TAYLOR et al. (1979).

(6) Among the "nearest neighbour points" methods mostly used in plant ecology, one of the simplest is the CLARK's and EVANS' (1954)

$$\bar{x} = \frac{1}{4r^2} \tag{8}$$

where $\bar{x}$ is the density per unit area, $\bar{r}$ is the average distance between neighbour points. According to WALOFF and BLACKITH (1962) the dispersion is random if $r^2 = 0{,}25/\bar{x}$, and in the case of uniform-hexagonal dispersion r^2 was $1{,}154/\bar{x}$ on the population of *Lasius flavus F.*

(7) PIELOU (1969, 1974) has shown the mistake of these estimating methods: the unit value of σ^2/m is a characteristic of the Poisson series but not exclusively. Pielou's method based on nearest neighbour technique and fitting test is very useful to investigate the dispersion of ant populations because micromaps of sedentary ant nests can easily be made for further analysis. Pielou's method is based upon the equation:

$$F(r) = Pr \text{ (distance to nearest neighbour } \leqq r).$$

This means the probability that a circle of radius r centered on a randomly selected point will contain at least one individual. Therefore

$$F(r) = 1 - e^{-mr^2} \tag{9}$$

where m denotes the mean number of individuals (nests) per circle. The fitting of data to the Poisson series can be tested by $\varkappa^2$ test in this case, too (PIELOU, 1974).

Among the works dealing with the dispersion of ant populations (TALBOT, 1943, 1954; BRIAN, 1956, WALOFF and BLACKITH, 1962; BARONI—URBANI, 1969; PETAL, 1972; GALLÉ, 1975, 1978) there are some in which it is shown that the dispersion of ant populations has a density dependent property (BRIAN, 1965; GALLÉ, 1975, 1978). When density is increasing the dispersion index is inversely proportional to density crosses decreasing from $V > 1$ to $V < 1$ (GALLÉ, 1975).

The basic hypothesis of the present paper is that the dispersion of ant populations is not random even in the temporary cases when $V \simeq 1$. Studying this problem it is also a purpose to investigate the applicability of indices based on estimation.

Methods

Samples were taken in two grasslands, sandy soil *Potentillo-Festucetum pseudovinae* (Bugacpuszta) and *Cynodonti-Poëtum angustifoliae* (near Tőserdő) with harder soil. Both of them are in the Kiskunság National Park.

Samples were contagious with size of one sq.m. One pattern consists of 20—39 samples. Since samples were dig up, all nests hidden in the soil were discovered. Therefore the density values got in this way are considerably higher than those published in the literature based only on the investigation of surface of soil.

Evaluating the data the following characteristics were estimated: density per 4 sq. m. ($\bar{x}$/4 m^2); density per sq. m. (x/m^2); index of dispersion (V); and its $\varkappa^2$ test ($\varkappa_v^2$). For Pielou's method micromaps were made on the position of nests and 50—50 points were chosen in a random way on them. The $\varkappa^2$ analysis was based on the number of ant colonies or nests being in the circles of „r" radius drawn from the points as centres. These $\varkappa^2$ values are marked $\varkappa_m^2$.

Results

In plant association *Potentillo-Festucetum pseudovinae,* in the research area of Zoological Department of Attila József University it was possible to identificate the dispersion of the nests of *Lasius alienus* FÖRST. and *Plagiolepsis vindononensis* LOMN.

Data of *Lasius alienus* population:

$$\begin{aligned} \bar{x}/4\ m^2 &= 4{,}4 \\ s^2 &= 2{,}3 \\ V &= 0{,}52 \\ \chi^2_v &= 2{,}09 \text{ on this basis } P_{RA} = + \\ \overset{*}{x} &= 3{,}92 \\ \overset{*}{x}/\bar{x} &= 0{,}89 \\ \chi^2_m &= 12{,}87 \text{ on this basis } P_{RA} < 0{,}05 \end{aligned}$$

As it can be seen on the basis of χ^2_v test, the probability of RA (random) dispersion can't be excluded, although a uniform dispersion is more probable owing to the value of V being smaller than unit and values of mean crowding and patchiness. The probability of RA dispersion can significantly be rejected on the basis of micromapping method. In this respect there is a contradiction between χ^2_v and micromapping method.

Ecological data of population of *Plagiolepis vidobonensis:*

$$\begin{aligned} \bar{x}/4\ m^2 &= 1{,}2 \\ s^2 &= 1{,}2 \\ V &= 1{,}0 \\ \chi^2_v &= 4{,}0 \text{ on this basis } P_{RA} = + \\ \overset{*}{x} &= 1{,}2 \\ \overset{*}{x}/\bar{x} &= 1{,}0 \\ \chi^2_m &= 12{,}87 \text{ on this basis } P_{RA} < 0{,}05 \end{aligned}$$

The estimating methods (V, χ^2_v, $\overset{*}{x}/\bar{x}$) support a random dispersion without doubt, but it must be rejected according to the micromapping method.

For analysing the dispersion of *Formica cunicularia* LATR., I investigated an area of several hundred sq. m., the number of nests was estimated and a micromap was made. The data of population:

$$\begin{aligned} \bar{x} &= 0{,}14 \\ s^2 &= 0{,}12 \\ V &= 0{,}88 \\ \chi^2_v &= 35{,}80 \text{ on this basis } P_{RA} = + \\ \overset{*}{x} &= 0{,}02 \\ \overset{*}{x}/\bar{x} &= 0{,}14 \end{aligned}$$

on the basis of χ^2_m $P_{RA} > 0{,}80$.

The V and patchiness are contradictory. The type of dispersion is random without doubt on the basis of micromapping analysis. Random dispersion is interesting in the case of *Serviformica* population with a relatively high density because the aggressive behaviour and probably also the ability for competition are very strong within the population.

On the basis of samples taken in a *Cynodonti-Poëtum* grass association near Tőserdő the dispersion analysis of *Tetramorium caespitum* L., *Diplorhoptrum fugax* LATR. and *Plagiolepis vindobonensis* can be made.

Characteristics of *Tetramorium caespitum* population:

$\bar{x}/4\ m^2 = 1{,}4$
$\bar{x}/m^2 = 0{,}35$
$s^2 = 0{,}70$
$V = 0{,}50$
$\chi_v^2 = 2{,}33$ on this basis $P_{RA} = +$
$\overset{*}{x} = 0{,}98$
$\overset{*}{x}/\bar{x} = 0{,}70$
$\chi_m^2 = 28{,}07$ on this basis $P_{RA} < 0{,}001$

The dispersion of this very dense population is uniform according to all indices.

Diplorhoptrum fugax:

$\bar{x}/4\ m^2 = 2{,}4$
$\bar{x}/m^2 = 0{,}6$
$s^2 = 1{,}3$
$V = 0{,}54$
$\chi_v^2 = 2{,}16$ on this basis $P_{RA} = +$
$\overset{*}{x} = 1{,}94$
$\overset{*}{x}/\bar{x} = 0{,}80$
$\chi_m^2 = 24{,}53$ on this basis $P_{RA} < 0{,}01$

Plagiolepis vindobonensis:

$\bar{x} = 1{,}8$
$\bar{x}/m^2 = 0{,}45$
$s^2 = 1{,}70$
$V = 0{,}97$
$\chi_v^2 = 3{,}77$
$\overset{*}{x} = 1{,}74$
$\overset{*}{x}/\bar{x} = 0{,}96$
$\chi_m^2 = 7{,}39$ on this basis $P_{RA} = 0{,}2-0{,}3$

In opposition to χ_v^2 test on the basis of χ_m^2 random dispersion can be rejected significantly on the populations of *Tetramorium caespitum* and *Diplorhoptrum fugax* and most likely on *Plagiolepis vidobonensis*.

Discussion

The density dependent character of dispersion is doubtless. When dispersion is changing from clumping to uniform type, a homogeneous or nearly homogeneous environment is most suitable to study the case when $V \sim 1$. From the grasslands studied *Cynodonti-Poëtum angustifoliae* meets this requirement. *Potentillo-Festucetum* covers relatively homogeneous parts of an inhomogeneous sandy soil grassland. This homogeneous level is dissected by wind furrows with fragment of *Schoenetum nigricantis* and *Molinio-Salicetum* grass assotiations. In these furrows *Lasius alienus* is replaced by small and isolated populations of *Lasius niger* L. If random samples had been taken from the whole area, it would have resulted clumping dispersion for both *alienus* and *niger* populations because randomly situated samples result in a clumping dispersion for both clumping population and its complement (PIELOU, 1969). This is true for the population of *Plagiolepis vindobonensis,* as well, on which wind furrows cause "holes". In these cases clumping dispersion is caused by the inhomogeneity of environment. The populations of low density are also in a similar situation: a population can survive at those points of an area having unfavourable conditions for it, where conditions are relatively favourable. On these places clumps are formed within that there is a minimal distance between nests. In space going to a place more favourable for the population in question, the number and size of clumps are increasing and at last they cover the whole area and the dispersion type of population becomes uniform (GALLÉ, 1975). So the population has a well-defined, organized structure in space all the time and the nests aren't situated randomly. Results of the present paper show that only Pielou's micromapping method is sufficient to test that property, while on the basis of estimating methods (V, patchiness) we get random dispersion in all cases when $V \simeq 1$.

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AUCHENORRHYNCHA OF THE UPPER TERRAIN OF A SAND SOIL GRASSLAND: QUANTITATIVE RELATIONS, BIONOMIC AND ECOLOGICAL-VALENCE DATA

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Abstract

In 1977—1978, from among the 38 Auchenorrhyncha species, found in the upper terrain of the sand soil grassland of Bugac (Hungary), the following were rather important: *Psammotettix provincialis, Aphrodes elongatus, Aphrodes bicinctus, Recilia schmidtgeni, Turrutus socialis, Philaenus spumarius, Lepyronia coleoptrata,* and *Agallia ribauti. Macustus grisescens* is a new species in Hungary. 48.6 per cent of the occurring species are univoltin species, 22.9 per cent are bivoltin species, both spending the winter in the form of eggs. In larval sha e 11.3 per cent, as imagos 17.1 per cent of them spend the winter. Dry-grass specific are 48.6 per cent, xerophilous are 32.4 per cent, indifferent of this are 10.8 per cent and non-characteristic 8.1 per cent.

Introduction

It was also demonstrated by the investigations carried out, so far, in different grass types that the Auchenorrhyncha group forms a characteristic part of their fauna (MARCHAND, 1953), particularly of the primary consument fauna, being in immediate connection with the primary production (ANDRZEJEWSKA, 1971). In a sheep-walk, Cicadae have formed the herbivore insects of highest abundance of the plant parts over soil surface (ANDRZEJEWSKA, 1974). These are similarly ranged among the primary consuments by OSBORN (1939), WEIGERT and EVANS (1967), HEWITT and BURLESON (1975, 1976), HAAS (1976), HOKKANEN and RAATIKAINEN (1977), and others. In Hungary, the grassland and meadow types of Hortobágy were biocoenotically surveyed (KOPPÁNYI and WOLCSÁNSZKY, 1956).

The present investigation is part of a complex research, begun in 1976 by the Department of Zoology of the Attila József University in a sand soil grassland in the area of Bugacpuszta, in the Kiskunság National Park (MÓCZÁR et al. 1980). According to the data of 1976—1978, Auchenorrhyncha represented at the upper terrain, within all the Insecta, 74.43; 31.65; resp. 24.07 per cent (GALLÉ et al, 1980). This justifies, as well, their investigation in detail, of which we undertake in this paper the elaboration of the material according to species composition, species dominance, bionomics (wintering, number of generations) and ecological valence.

Methods

The detailed description of the investigated area and methods were given earlier (MÓCZÁR et al. 1980; resp. GALLÉ et al., 1980). From the strongly enough separated two terrains: the Auchenorrhyncha fauna of the higher lying ridges is treated here. The characteristic plant associations

are: *Potentillo-Festucetum pseudovinae danubiale* and *Festucetum vaginatae danubiale*. Collection took place from March till November, generally once a month. Biocoenometric collections were carried out in 1976 with informative character, completed with grass netting (GALLÉ et al., 1980).

To determine the Cicadae, I have used primarily the works of RIBAUT (1936, 1952) and DLABOLA (1954). Nominations are corrected according to NAST (1972). Some bionomial and ecological-valence data are completed from the works of SCHIEMENZ (1969, 1971, 1975, 1976).

Results

1. Qualitative and quantitative species composition

For evaluating the dominance relations, I have used Schiemenz's division, according to which (D-dominance):

D-group	D per cent	
+	<1	accessory species
1	1—4	
2	4—16	subdominant species
3	16—36	dominant species
4	36—64	
5	64—100	

According to SCHIEMENZ (1969)

On the basis of this, the dominance relations of the Auchenorrhyncha populations of the upper terrain are the following (Table 1).

Dominant species were in 1977 two *(Aphrodes elongatus, Psammotettix provincialis)*, in 1978 only one *(Psammotettix provincialis)*. Subdominant were in 1977 two, in 1978 seven species. The species with a dominant role on the ridges of sand-hills were, therefore, the following: *Psammotettix provincialis, Aphrodes elongatus, Aphrodes bicinctus, Recilia schmidtgeni, Turrutus socialis, Philaenus spumarius, Lepyronia coleoptrata, Agallia ribauti, Zyginella* sp. This agrees well with the results of ANDRZEJEWSKA (1971) in the proportions of the division of species dominance. The comparatively extreme environmental factors ensure adequate living conditions only to a few species. Therefore, apart from a few dominant populations, the number of „residual" elements is high. A number of these probably stay as guests in the upper, drier terrain, their real living-space is in the wind-furrows. Investigations referring to this are the subject of a future work.

II. Data on the bionomics of the occurring species

The wintering quality of the occurring populations, the number of developing generations may be characteristic of a given ecosystem. At the investigated sand soil level this took place in the following way:

1) There are wintering in imago form:

a) In one generation:

Jassidaeus lugubris — *Ulopa trivia*

b) In two generations:

Agallia ribauti — *Eupelix cuspidata*
Arboridia parvula — *Neoaliturus fenestratus*

Table 1. Auchenorrhyncha dominance relations in 1977–1978.

Species	1977		1978	
	D p.c.	DG	D p.c.	DG
Agallia ribauti Oss.	3.14	1	2.79	1
A. sinuata M. R.	4.92	2	0.55	+
Aphrodes albiger Germ.	—	—	0.83	+
A. bicinctus Schrk.	6.99	2	6.56	2
A. elongatus Leth.	16.36	3	5.93	2
Arboridia parvula Boh.	0.06	+	0.83	+
Artianus interstitialis Germ.	0.16	+	0.27	+
Batracomorphus allionii Turt.	0.03	+	–	–
B. irroratus Lew.	0.20	+	0.27	+
Bobacella corvina Horv.	0.30	+	–	–
Chanithus pannonicus Germ.	0.50	+	0.27	+
Doratura homophyla Flor.	0.60	+	0.27	+
D. stylata Boh.	3.74	1	0.27	+
Zyginella sp.	1.13	1	12.01	2
Eupelix cuspidata F.	0.71	+	–	–
Euscelis plebejus Fall.	1.17	1	–	–
Goniagnathus brevis H. S.	0.24	+	–	–
Hecalus glaucescens Fieb.	3.66	1	3.07	1
Jassidaeus lugubris Sign.	–	–	0.55	+
Kelisia sp.	0.97	+	2.51	1
Lepyronia coleoptrata L.	2.66	1	5.87	2
Macustus grisescens Zett.*	–	–	0.27	+
Mendrausus pauxillus Fieb.	1.90	1	0.27	+
Neoaliturus fenestratus E. S.	0.81	+	1.66	1
Neophilaenus infumatus Hpt.	1.42	1	0.55	+
Ommatidiotus incospicuus Stal.	0.50	1	1.11	1
Paluda preyssleri H. S.	–	–	0.27	+
P. vitripennis Flor.	0.28	+	0.27	+
Philaenus spumarius L.	2.89	1	6.91	2
Psammotettix alienus Dhlb.	1.61	1	0.54	+
P. confinis Dhlb.	3.83	1	2.79	1
P. pallidinervis Dhlb.	0.06	+	–	–
P. provincialis Rib.	31.65	3	22.71	3
P. striatus L.	0.06	+	–	–
Recilia schmidtgeni Wagn.	1.63	1	–	–
Trypetimorpha fenestrata Costa.	0.12	+	–	–
Turrutus socialis Fl.	2.00	1	7.82	2
Ulopa trivia Germ.	1.97	1	0.83	+
Other Cicadellidae	1.49		2.32	
Other Delphacidae	–		1.11	

D = dominance DG = dominance group

* This is a new species in Hungary

2) There are wintering in larval form:

a) In one generation:

Bobacella corvina *Macustus grisescens*
Hecalus glaucescens

b) In two generations:

Euscelis plebejus

3) There are wintering in egg-shape:
a) In one generation:

Agallia sinuata
Aphrodes albiger
Aphrodes bicinctus
Aphrodes elongatus
Artianus interstitialis
Batracomorphus allionii
Batracomorphus irroratus
Chanithus pannonicus
Doratura homophyla
Doratura stylata
Goniagnathus brevis
Lepyronia coleoptrata
Mendrausus pauxillus
Neophilaenus infumatus
Ommatidiotus incospicuus
Paluda preyssleri
Philaenus spumarius

b) In two generations:

Paluda vitripennis
Psammotettix alienus
Psammotettix confinis
Psammotettix pallidinervis
Psammotettix provincialis
Psammotettix striatus
Recilia schmidtgeni
Turrutus socialis

The majority of species (48.6 p. c.) are univoltin and they winter in egg-form; 22.9 p. c. are bivoltin and winter in egg-form. Comparing these data with the values obtained in boggy meadows, resp. dry grasslands (SCHIEMENZ, 1969), there is a high-degree identity with the dry grasslands (Table 2).

Table 2

	bog (Sch)	dry grassland (Sch)	own data
imago is wintering	9.6 p.c.	19.1 p.c.	17.1 p.c.
larva is wintering	26.9	10.3	11.3
egg is wintering	63.5	70.6	71.5

Sch = SCHIEMENZ (1969)

III. Division of the occurring species according to ecological valence:

1) Stenotopic species (X) in xerothermous biotopes, in Central Europe they only live in dry grasslands:

Arboridia parvula
Artianus interstitialis
Batracomorphus irroratus
Chanithus pannonicus
Goniagnathus brevis
Hecalus glaucescens
Jassidaeus lugubris
Mendrausus pauxillus
Neoaliturus fenestratus
Neophilaenus infumatus
Ommatidiotus incospicuus
Paluda preyssleri
Paluda vitripennis
Psammotettix pallidinervis
Psammotettix provincialis
Psammotettix striatus
Recilia schmidtgeni
Ulopa trivia

2) Eurytopic species:
a) They live in xerophilous and mesophilous biotopes but their centre of gravity is displaced towards the xerophilous character. $(\underline{X-M})$:

Trypetimorpha fenestrata
Agallia sinuata
Agallia ribauti
Aphrodes albiger
Aphrodes elongatus
Batracomorphus allionii
Bobacella corvina
Doratura homophyla

b) They occur equally in xerophilous, mesophilous and hygrophilous biotopes but they prefer the first of these ($\underline{X}-M-H$):

Euscelis plebejus — *Doratura stylata*
Eupelix cuspidata — *Turrutus socialis*

c) They occur in all the three biotope types, without preferring any of them ($X-M-H$):

Aphrodes bicinctus — *Psammotettix alienus*
Lepyronia coleoptrata — *Psammotettix confinis*

d) They prefer the mesophilous biotope ($X-\underline{M}-H$):

Athysanus argentarius

e) They prefer the mesophilous and hygrophilous biotopes ($X-\underline{M}-\underline{H}$):

Philaenus spumarius — *Macustus grisescens?!*

The dry-grassland specific species dominate: 48.6 per cent; the dry grassland is preferred by 32.4 per cent; 10.8 per cent are indifferent to the dry grasslands; and 8.1 per cent are not characteristic. Compared with SCHIEMENZ's data (1969), there the percentage is 44.1, 24.3, 21.7, and 9.9. It appears from all these that from among the Central European dry grassland the one investigated by us belongs to those being under more extreme environmental conditions where the quality of the populations that are able to survive is more strongly determined by the pressure of selection.

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INVESTIGATION INTO SOME RESPIRATION-DETERMINING ECOLOGICAL FACTORS ON LARVAE OF PALINGENIA LONGICAUDA OLIV. (EPHEMEROPTERA)

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Abstract

From among the respiration-determining environmental factors of the may-fly larvae we have investigated the effect of substratum, water temperature, and development. The presence of substratum is absolutely necessary in case of larvae with burrowing way of life. With rising temperature, particularly in a younger age, oxygen consumption increases. The oxygen consumption of younger larvae falling on body-weight unit, is always a multiple of that of older ones.

Introduction

The respiratory organs of the may-fly larvae with burrowing way of life, the tracheal gills, are considerably accomodated to the utilization of the oxygen dissolved in water and are very sensitive to the quantitative change in this. In addition the intensity of the respiration of animals is considerably affected by other abiotic factors (presence or missing, quality of a substratum, water temperature, light conditions) and biotic factors (e. g. development in the larval age), as well. The knowledge of the effect of the different ecological factors determining respiration, is absolutely necessary to the bioenergetic research work, coming into prominence in our days. In case of aquatic insect larvae (Plecoptera, Ephemeroptera) these were investigated by several researchers. ERIKSEN (1968) emphasizes the role of the substratum and water. He establishes that a substratum of a quality characterizing the species and the same water, in wich the animal is to be found under natural conditions must be used in the experiments. According to FELDMETH (1970) in case of rheophilous species we only obtain real values of oxygen consumption if they are measured in flowing water. In Kamler's experiments (1970) the size of body, development, quantity and quality of food, the respiratory movements are all factors influencing oxygen consumption.

The methods of measuring respiration are very varied. KAMLER (1969) investigated both Plecoptera and Ephemeroptera larvae in a measuring machinery of a closed system, with and without flowing water, and she constructed together with KLEKOWSKI (1968) a respirometer founded on the principles of polarography. CSOKNYA (1973) measured the oxygen consumption of *Palingenia* larvae with Warburg's manometric process. Nagell's apparatus (1973) in wich he investigated into

four different Plecoptera and Ephemeroptera species, is an open system with flowing water, and the oxygen consumption is registered by a drop electrode.

Similarly to the mentioned apparatuses we have constructed a respiration machinery and investigated under laboratory conditions some factors affecting the respiration of may-fly larvae.

Methods

Our measuring instrument is an apparatus of closed system, making waterflow with a speed of 4 litre/min. (CSOKNYA and HALASY, 1975). It registers the quantitative changes of the dissolved oxygen in an electrochemical way, with the help of a voltametric sensing electrode (a construction of the Measuringtechnical Central Research Laboratory). The obtained values of current intensity can be reckoned over into a dissolved oxygen/ml water quantity by means of a calibration curve.

The experimental animals, collected from the Tisza and Maros rivers, were ranged into five groups according to their development. In every weight group oxygen consumption was measured at 5—10—15—20—25 °C temperatures, carrying out three paralell measurements in each. The duration of each measurement was two hours.

Results

Two experimental series were carried out. In the first one no substratum was applied, in the second some tubes made of plastiline served as a substratum. Results of the two experimental series were compared in a graph in each group (Figure 1, I—V). On the horizontal axis of these the temperature, on their vertical axis the oxygen consumption taken for 1 mg dry weight are indicated.

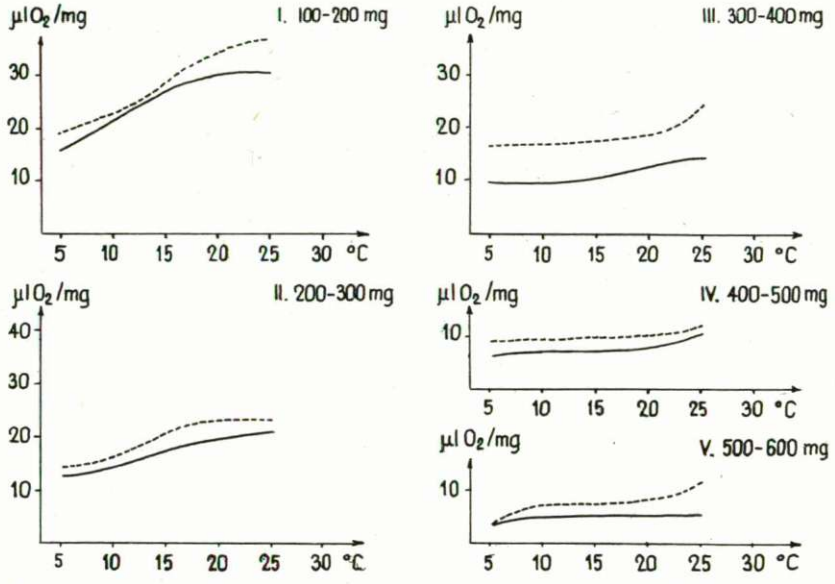

Fig. 1. Values of oxygen consumption related to dry weight and divided according to weight groups (— with substratum; - - - - without substratum)

It appears from our results that from among the abiotic factors, the presence of the substratum making burrowing possible has a decisive role. The experiments carried out with a substratum, resulted namely in a lower oxygen consumption in every weight group and at any temperature, than those without any substratum. The explanation of this is that in the plastiline tubes the test animal got under conditions that are closer to natural, i.e. to the state of rest.

The younger larvae respond livelier to the rise in water temperature. This manifests itself so that the intensity of their respiration increases stronger than in the older groups (e. g., while the 10 °C change between 5—15 °C in groups III, IV and V changes almost nothing in oxygen consumption, in groups I and II the oxygen consumption considerably increases).

Knowing the natural living conditions of larvae as well as in our preliminary experiments, we have ascertained that light has a disturbing effect because of the negative phototaxis of larvae. We have, therefore, already taken care in both experimental series that they should be placed in total darkness.

The only biotic factor, taken into consideration by us, was the development of larvae. The weight of animals was taken as a measurement of this. Corresponding to the higher intensity of metabolism of the younger animals, the oxygen consumption of the younger animals — larvae of smaller veight — (Fig. 1; I and II) proved to be considerably higher than that of the older ones (Fig. 1; III, IV, V).

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ON THE INSECT FAUNA OF THE ALKALI FLAT AT KISKUNDOROZSMA

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Abstract

The monthly distribution of the dominant elements of the Arthropoda fauna in *Lepidio-Camphorosmetum* and *Lepidio-Puccinellietum limosae* associations on calcareous-sodic solonchak soils of a strongly alkali flat at Kiskundorozsma, near Szeged was investigated. Barber-traps were used for catching the arthropods totalling nearly 100 000 specimens.

The extensive alkali flats in the Danube—Tisza Mid-region have been greatly diminished and today, in its original state, only some small patches are extant in the environs of Szeged. These harbouring some endemic or rare species and associations were put under nature conservancy only recently (BODROGKÖZY, 1962, 1974). The alkali flat at Kiskundorozsma, near Szeged has a varied fauna of which SZILÁDY (1925) published a mere fraction discussing those of Chilopoda, Arachnoidea and some Acariformes, thus, the fauna of insects discounting some sporadic collectings, and the limnological investigations (FERENCZ, 1973; MEGYERI, 1972) is almost wholly unknown. This is the reason why we set as a target to elucidate the monthly distribution of at least the dominant species or groups of the arthropoda fauna of this region.

Investigated area

According to BODROGKÖZY (1962) South Kiskunság may be divided into the following zones: sand-dune, sand-bank, extreme saline zone (vakszik), halomorphic soil patch, inundation area, foreshore, sandy river-bank, bank zone with permanent water, deep-water zone. For our research we chose the extreme saline zone and the halomorphic soil patch at Kiskundorozsma as for the prevalence of extreme conditions.

This region belongs according to the classification of STEFANOVITS (1963) and ÁBRAHÁM—BOCSKAI (1971) to the calcareous—sodic solonchak soil type. The only prevailing association in this area is the *Lepidio—Camphorosmetum* standing well up to high concentration of Na_2CO_3, with only two species: *Lepidium crassifolium* and *Camphorosma annua*. The root system of these plants reach down into deep soil layers and is hemicryptophyte, appearing in the beginning of March in great masses,

with a total coverage of less than 10—15%. In order to inprove the alkali soil *Puccinellia limosa* was introduced. Thus, in this way, partly in an artificial way the *Lepidio-Puccinellietum limosae* came about as secondary association being characteristic for the solonchak soil, that become dry at the end of spring. Dominant species are *Puccinellia limosa, Lepidium crassifolium* and *Plantago maritima* with a total coverage of 50%.

Methods

To draw reliable conclusions on the arthropod population of a region applying emergence traps at least 1—2 years of continuously functioning traps are necessary. This is especially applicable to the alkali soil whose vegetation is temporary, and occasionally rather poor. The emergence trap was introduced by SOUTHWOOD (1971) in "Central High Alps: Obergurgl-area, Tirol" and functioned by the Zoological Institute of the University of Innsbruck (JANETSCHEK and co-authors 1976). The basic area of the trap is 50×50 cm, height of iron framework 40 cm (Fig. 1—3), while the plastic collecting box fixed at the top is about 60 cm from ground level. The inner space is covered with a dark tulle material forcing the emerging animals to crawl upwards into the white plastic box. This latter contained 2—3% potassium bichromate solution in 1976, in 1977 50% ethylene-glycol solution. The thus enclosed 0.25 m² surface area was further supplied with a Barber-trap with ethylene-glycol in it (Fig. 3) in order to collect animals unable to fly. Both traps (upper and lower) have been evaluated separately, too.

Table 1. The average of those traps which captured more animals in the Barber-traps (lower trap) than in the upper ones, — variable position, c — constant position.

	lower trap		upper trap	place of traps	
				variable	constant
1976. VI	59.8	Hymenoptera	20.9	v	
	37.8	Collembola	2.6	v	
	18.0	Collembola	3.2		c
1976. VII	5	Araneidea	2.2		c
	9.8	Homoptera	6.2		c
	3.8	Collembola	1.6		c
	30	Hymenoptera	21.6	v	
	10	Araneidea	3.4	v	
	4.6	Homoptera	2	v	
1976. VIII	1.2	Orthoptera	0.4		c
	531	Collembola	293.8	v	
1976. IX	639.8	Collembola	156.8		c
	748.6	Collembola	64.4	v	
1977. V	3	Collembola	—		c
	30.4	Hymenoptera	27.8	v	
1977. VI	19.8	Araneidea	16.6		c
1977. VII	15	Hymenoptera	10.8	v	
1977. X	554.8	Collembola	94.6		c
	105	Collembola	75.6	v	

Fig. 1—3. The *Lepidio-Puccinellietum limosae* association at Kiskundorozsma, 1— surface area 5×5 m (at June 3, 1976), 2 — emergence traps of constant position and variable position (at June 29, 1976), 3 — Barber-trap overturned most likely by a *Spalax leucodon* specimen (at July 29 1976) (Original).

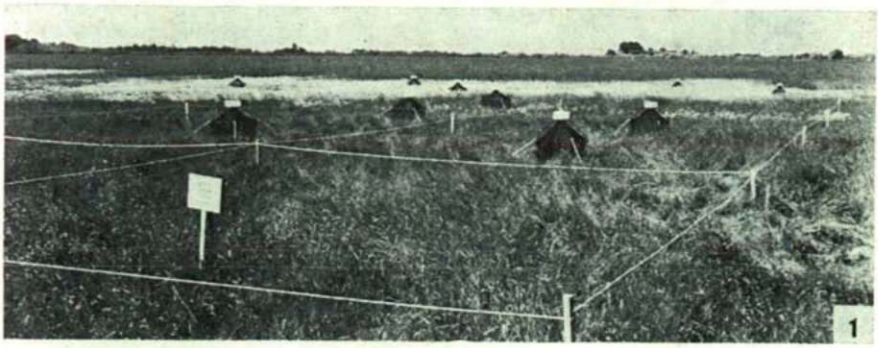


Fig. 1—3

The traps in 1976—1977 were placed out in areas some 800 m from one another in June (in May the areas were under water) and May until November, respectively, and were emptied once a month. Out of the 10 traps five remained in place over the entire vegetation period, while the position of the other five was changed monthly (Fig. 4—5).

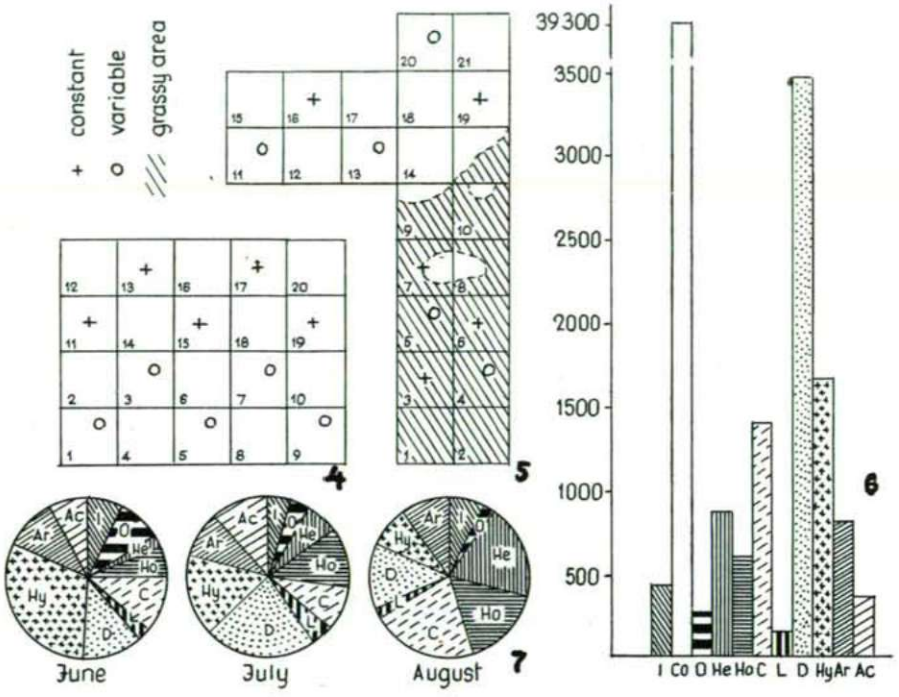


Fig. 4—5. Placing out emergence traps, 4 — in June 1976, 5 — in May 1977, o of changed (= variable) position, + constant position. — Fig. 6. Mean values of total number collected in 1976—1977. — Fig. 7. Summer changes in two-year averages of the ten most important orders.

The method of trapping allowed to draw the following conclusions. The 10 upper traps collected significantly greater number of specimens throughout the two-year period in each month than the 10 lower ones, the only exceptions in the two years are shown in Table 1. (In comparison the Isopoda were not considered.)

Owing to damage to the covering net, only insignificant number of animals reached the inner space, so this fact did not influence results, rather did though the number of animals that escaped through the slit, this was shown by a much lower number of animals caught.

The emerged and captured animals in both the five that remained in place and the other five that were constantly moved traps showed a perceptible fluctuation according to months: these were Orthoptera, Collembola and Hymenoptera. The fluctuation of the Isopoda population was obviously the result of the rather variable weather conditions (Table 2).

The data given in Table 1 and 2 also clearly indicate that no significant difference exists between the values of the two sets of traps. The climatological data used in our evaluation have been taken over from the Aerological Observatory at Szeged (Anonym, 1978) given in Tables 3.

Table 2. The variation of the average of specimen number in the different months (the four most important orders).

		1976					1977					
		VI	VII	VIII	IX	X	V	VI	VII	VIII	IX	X
Isopoda	c	16.6	5.6	2.4	2.8	5	1.6	8.6	9	8.8	10.6	22.8
	v	10.6	16.8	0.8	1.4	2.4	3	11.8	3	4.4	12.2	12.6
Collembola	c	21.2	5.4	664.6	796	3070	475	128	320	370	71	649
	v	40.4	3.8	824	813	1826	4704	477	186	122	23	181
Orthoptera	c	6.2	8.4	1.6	1.4	0.8	—	13	9	8.6	0.2	—
	v	5.2	18.8	1.4	0.6	0.4	—	12	10	6.8	—	—
Hymenoptera	c	58.2	68.4	13.8	10	0.8	35.2	48.6	28	12	2.8	4
	v	80.7	51.6	19.8	8.8	0.4	53.2	132	12	25.8	6.4	1.2

Table 3. Data of climatic conditions in the environs of Szeged in 1976 and in 1977.

Time (month)	Mean temperature SZEGED (°C)	Absolute maximum of temperature SZEGED, (°C)	Absolute minimum of temperature SZEGED, (°C)	Mean soil temperature SZEGED, 13h			Relative humidity (%)	Duration of sunshine (hour)	Total precipitation (mm)
				2	10	20			
				cm					
April	11.4	24.8 (IV. 4.)	0.6 (IV. 1.)	17.8	13.8	11.3	58	172	57
May	15.3	27.6 (V. 20.)	0.0 (V. 1.)	23.2	18.4	15.8	63	249	44
June	17.9	32.0 (VI. 21.)	6.0 (VI. 2.)	26.9	22.0	19.3	60	278	27
July	21.4	33.9 (VII. 21.)	9.2 (VII. 12.)	31.9	26.3	24.1	56	291	27
Aug.	17.9	28.1 (VIII. 29.)	8.2 (VIII. 7.)	26.1	21.6	20.2	65	218	31
Sept.	15.3	30.5 (IX. 14.)	6.0 (IX. 7.)	21.5	18.1	16.7	77	154	46
Oct.	11.9	27.7. (X. 3.)	2.8 (X. 23.)	17.6	14.4	13.2	80	139	29
Yearly total	10.0	—	—	15.6	12.4	11.2	71	1903	443
April	8.9	25.0 (IV. 30.)	−1.4 (IV. 12.)	15.1	10.9	9.6	73	177	49
May	15.9	29.2 (V. 20.)	4.8 (V. 27.)	23.2	19.2	17.3	70	245	39
June	19.5	32.7 (VI. 14.)	−2.9 (VI. 4.)	28.6	24.1	22.1	65	298	35
July	20.3	33.4 (VII. 31.)	10.4 (VII. 28.)	28.2	23.8	22.2	65	277	45
Aug.	20.1	31.7 (VIII. 10.)	8.0 (VIII. 26.)	28.1	23.3	21.6	70	233	36
Sept.	14.1	29.8 (IX. 5.)	−0.7 (IX. 29.)	22.9	18.4	17.5	70	209	46
Oct.	11.2	25.8 (X. 8.)	−0.1 (X. 18.)	18.4	13.2	12.2	75	171	7
Yearly total	10.7	—	—	16.4	13.0	11.9	76	2020	477

Table 4. Specimen number of large categories in monthly distribution. Abbreviations: G — Gastropoda, I — Isopoda, Di — Diplopoda, Chi — Chilopoda, Co — Collembola, O — Orthoptera, Th — Thysanoptera, He —Heteroptera, Ho — Homoptera, N — Neuropteroidea, C — Coleoptera, L — Lepidoptera, D — Diptera, Hy — Hymenoptera, Ar — Araneidea, Ac — Acariformes, Juv — juvenile.

1976

Order / Month	G	I	Di	Chi	Co	O	Th	He	Ho	N	C	L	D	Hy	Ar	Ac	Juv
June	16	136	2	—	308	57	—	30	161	—	275	3	2891	695	176	155	169
July	11	112	—	—	46	136	—	8	113	1	125	6	99	600	103	10	5
August	6	17	—	—	7 445	15	3	19	264	—	66	23	233	168	50	39	70
Sept.	20	21	—	—	8 048	10	—	187	241	—	187	28	118	94	31	—	9
Oct.	18	37	3	—	24 482	5	—	18	56	—	96	1	15	6	18	—	6
Yearly total	71	323	5	—	40 329	223	3	260	835	1	749	61	3356	1563	378	204	259

1977

May	1	23	—	2	25 554	—	1	933	26	1	517	9	1922	427	126	84	92
June	3	96	—	—	3 026	125	1	121	249	12	668	52	967	900	543	25	55
July	4	59.5	—	1	2 651	96.5	4	49	43	1	153.5	50	195	159	156.5	179.5	47
August	1	66.5	1	—	2 564	79.5	2	142	30	—	137.5	99	332	229	180.5	221.5	106
Sept.	2	114	1	1	467	1	—	160	8	—	224	14	92	46	146	—	13
Oct.	1	175	5	8	4 045	—	—	82	22	—	404	2	105	26	108	—	29
Yearly total	12	534	7	12	38 307	302	8	1487	378	14	2104	226	3613	1787	1260	510	342

Evaluation of material

Over the 11 months of collecting time 99 610 specimens of arthropod were collected. The members of the individual orders are shown in Table 4 broken down to months, while the average number for the two years is given in Fig. 6.

In the summer months the fluctuation of numbers in the most important 10 orders is given in Fig. 7 as the means of the two years. The members of the orders Orthoptera and Hymenoptera in summer play a less significant role, while those of Coleoptera, Heteroptera and Homoptera greatly increase in number. A comparative stability is seen in Isopoda and Araneidea. The emerging imagoes of Lepidoptera and Diptera reach the highest number in July. New individuals of Acariformes do not emerge at the end of summer. The Collembola populations owing to their great number are not included herein.

The mentioned systematic categories well indicate the percentual compositions however, the zoocenosis could only be ascertained if the entire material were broken down to specific level, thus the structural elements built up along the food-chain (SZELÉNYI 1955) were grouped accordingly. However, our present aim was to survey the large categories persuing the same mode of life.

Scavenger elements

The consumers of dead plant and animal remains are primarily the Collembola (Fig. 8). Their number in October, 1976, following a small drop in number, sharply rose. The peak was reached in May, 1978 this was again followed by a decrease, however, once more in October a slight increase was observed. Life-conditions in May and in October are most favourable for Collembola: relative humidity (Tables 3, temperature of the soil surface as well as in the air is not too low, nor is it too high. In the two peak periods of increase the vegetable production reaches its maximum, while in the intermediate period the temperature sharply rises and the precipitation drops. Consequently, the best periods for food-intake are in spring and at the end of summer. The contradictory maximum also recorded over the two-year period may be due to the inadequately known life-cycle of Collembola (special attention should be paid to their development during the winter months), or very likely also to the extreme conditions of the two sites being some 800 m apart. In 1976 the research area was mowed and humans as well as animals freely moved about it. On the other hand, in 1977 the area was protected from such influences.

The following species of Collembola were collected in 1976 at Kiskundorozsma (identified by I. LOKSA):

Xenylla maritima TULLB.
Entomobrya marginata TULLB.
Bourletiella viridescens STOCK, s. GIS.
Orchesella cincta (L.)
Lepidocyrtus cyaneus TULLB.
Lepidocyrtus paradoxus UZEL
Isotoma viridis BOURL.
Seira pallidipes REUT.
Podura aquatica (L.)

The terricolous *Xenylla maritima* was represented in a strikingly high number. For example, in August, 1976 1588 adult and 428 juvenile specimens were captured in the upper collecting box of trap No. 19. At the same time the soil trap of this very apparatus only 68 adults and 40 juveniles were collected. On the other hand, in trap No. 15 the upper and lower traps showed the following values: 1094+244 and 106+86. The number of specimens in the other traps was greatly varying, or rather low. The number of the other species compared to *Xenylla,* similarly to results obtained in Bugac, is insignificantly small.

Among the other scavengers from the adult and juvenile forms of Isopoda the species *Armadillidium vulgare* LATR. was the most frequent (Table 4; Fig. 9). The graph showing the quantity of Isopoda in both years is very similar (Fig. 10) though one month difference exists between the two. Since in 1977 already in June there was a maximum value, that was smaller than the respective value for 1976. From thereon the number of Isopoda in the traps gradually decreases but in August it rises again. The one month delay in 1976 was caused by varying weather conditions. Since *Armadillidium vulgare* favours the dry, warm condition, consequently, the sunny weather with less precipitation at the end of summer of 1977 was promoting a good

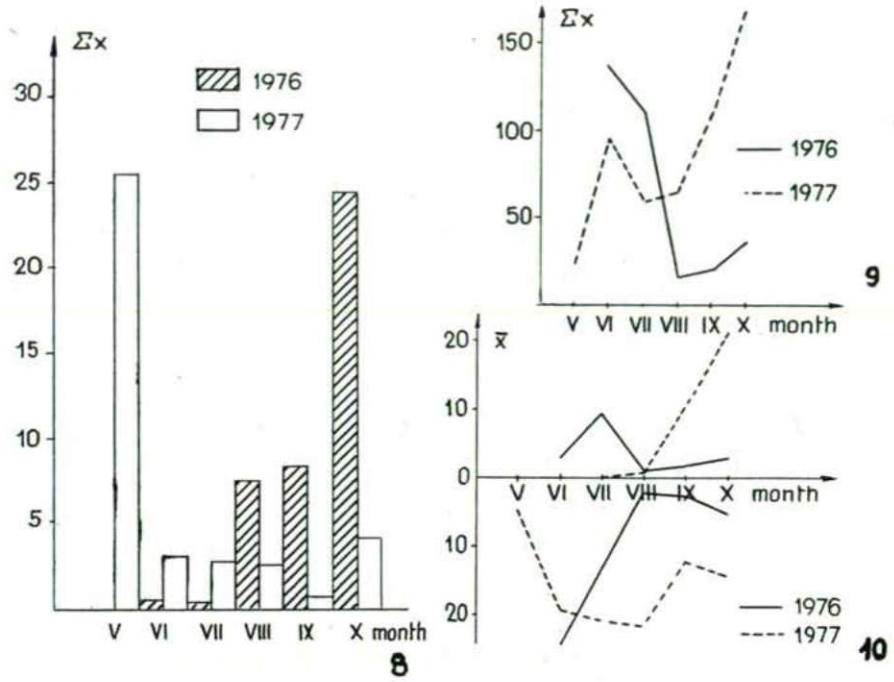


Fig. 8. The quantity of the most important scavenger element: Collembola. — Fig. 9. The total of Isopoda in 1976—1977. — Fig. 10. The average of specimen number of Isopoda in the upper and lower traps.

proliferation (Fig. 9). There is a difference between the catches of the upper and the lower traps (Fig. 10). Obviously the soil-traps catch a better number of specimens unable to fly than the upper traps. On the other hand, interestingly enough the number of captured specimens from August in 1976 is the same for the upper as well as for the lower trap. In 1977 the soil-traps showed an early maximum that was quite prolonged.

Only a very small number of Diplopods were collected over the two-year period, a total of 12 specimens. The very common *Polydesmus complanatus* POLAT was also captured here. In both years the best month was October (Table 4), very likely it was due to the cooler and more humid climate.

A part of Coleoptera occurred as the members of Staphylinoidea, but some obstant elements were also among them. Quantitatively they were insignificant.

Corrumpent elements

Most important representatives are the members of the suborder Acridoidea in Orthoptera. A rather less number of Tettigonoidea was observed, while no specimens of Grylloidea were present. As primary consumers a large number of juvenile specimens was captured especially in May and June. As they progressed in develop-

ment the imagoes became dominant in summer months. The change in the total number of specimens over the two years is shown in Fig. 11, while the mean values of the soiltraps are given in Fig. 12. Among the yearly totals the one in 1976 was the highest, but after adjustment of the average values (Fig. 12) the one for 1977 came out better. The peak values both for the upper and lower traps in both years were more or less the same. The peak of proliferation in 1977 was somewhat prolonged. This might have been influenced by the higher vegetal production of 1977. The average values show identical courses, the maxima in both years well correspond. The height of graphs (Fig. 12) according to the movement of Orthoptera is different in the upper and in the lower traps. The zero-values indicate the spring and late autumn months, when the animals were either in eggs or in very young larval stadia. This especially emphasizes the basic principle of emergence traps, i.e. by using it we collect specimens emerging from the soil, or those living in that particular covered surface area.

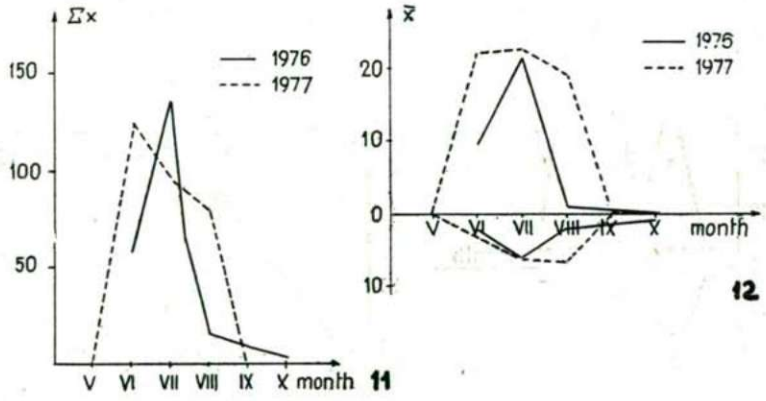


Fig. 11. The total of the most important corrumpent element: Orthoptera, for the two years. — Fig. 12. The average of specimen number of Orthoptera in the upper and lower traps.

The populations of Homoptera yielded a higher number of individuals than those of the previous group (Table 4, Fig. 13), but owing to their minute size, obviously their significance is only secondary. The traps mainly collected the members of the following superfamilies: Auchenorrhyncha, Psyllina and Aphidina. The populations of these superfamilies proliferated in different times (Fig. 13). In 1976 the members of Auchenorrhyncha were common in the second half of summer, well illustrated by the graph representing the upper trap. In 1977 the number of Psyllina and Aphidina was higher and the peak occurred already in June, compared to July—August in the previous year. The collectings of the upper and lowers traps were proportional in 1977. While the same cannot be said for 1976, since for the upper trap maximum the soil-traps showed a July maximum. This is justified by the juvenile proliferation to be caught in the soil-traps, while in August the adult specimens easily reached the upper traps owing to their ability to fly.

From among Heteroptera (Fig. 14) primarily the phytophagous species have been captured. The May maximum in 1977 coincided with the best production of

plants. On the other hand, their number is strikingly low in 1976, and the catches in September—October comprised mainly juvenile specimens.

The members of Lepidoptera (Fig. 15) are rather insignificant, only the Microlepidoptera were in measurable number.

Owing to their larval food Hymenoptera may be ranked among the corrumpent elements, too including the gall-making Cynipoidea populations. In 1976 their number was small, on the other hand, strikingly large number (179 specimens) emerged in 1977 (Table 5).

Rarely some species of Thysanoptera were also captured.

Among the larvae the members of the following orders have been recorded: Lepidoptera, Coleoptera, Heteroptera and Diptera.

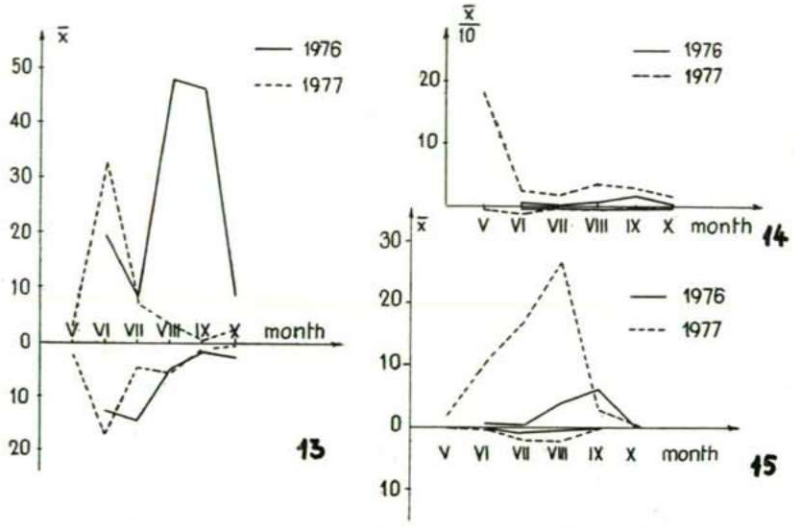


Fig. 13. The average of specimen number of Homoptera in the upper and lower traps. — Fig. 14. The average of specimen number of Heteroptera in the upper and lower traps. — Fig. 15. The average of specimen number of Lepidoptera in the upper and lower traps.

Obstant elements

These are the secondary consumers, obstracting over-proliferation, primarily the populations of Araneidea (Table 4). In both years their populations were the highest in both sets of traps in June (Fig. 16).

Among the insects the great majority of Hymenoptera belong to the obstant elements mainly due to the larval development (Tables 4 and 5): Inchneumonoidea, Chalcidoidea, Proctotrupoidea, Bethyloidea, Scolioidea and Sphecoidea, while Formicoidea belongs here also on imago basis too. Hymenoptera are most numerous, as it has been proved by the two-year research, in June (Fig. 17). The distribution of superfamilies are given in Table 5. Owing to the fact, that when selecting a site

for the erection of a trap we avoided the proximity of ant-nests, their number is below to their supposed significance in that area.

The two-year total of Diptera (Table 4), as their number broken down to months, always surpasses the same of Hymenoptera. Their significance is nevertheless comes after Hymenoptera, since Tachinidae were represented by a small number of individuals only. The graph (Fig. (18) shows the changes of Diptera totals without regard to obstant or sustinent elements. The early spring increase reaches its peak in May—June. In July scarcely any new emergence takes place. While in August emergence again in on the increase, but after that their number gradually decreases.

The number of emerged Neuropteroidea is comparatively small. The maximum for the fully developed imagoes is in June (Table 4).

The graph of Coleoptera (Fig. 19), similarly to Diptera, comprising the total of specimens, shows the fluctuation in monthly units. The number of Coleoptera in 1977 was better than in 1976, since the June maximum was followed by a secondary peak in September. Due to their agility a greater number of beetles was captured in the upper than in the lower traps. It should be noted that Coleoptera, both as larvae and adults, and also to the rather heterogenous mode of life of the various groups, may only be partly ranked as obstant elements (e.g. Carabidae, Coccinellidae, Cicindelidae).

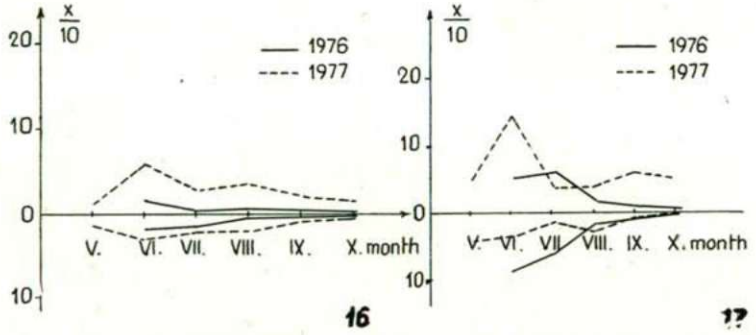
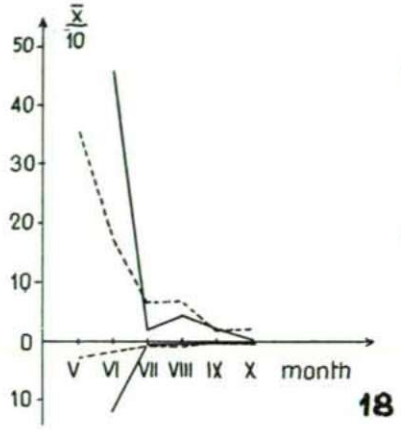


Fig. 16. Among the obstant elements the number of Araneidea is significant. — Fig. 17. The average specimen number of Hymenoptera.

Sustinent elements

The rest of the insects, like Apoidea, some Diptera (e.g. Syrphidae), many groups of Coleoptera help fertilization of plants. The data of Fig. 17—19 would yield only after a detailed study of the species composition the monthly changes of sustinent elements. It is most likely that the water covering the area in 1976 entirely abolished the Apoidea population, since no specimen emerged. Their number in 1977 was very small because they build nests in loose, sandy soils, rather than in hard, alkali soils.

In summary we may establish that the emergence traps placed out at Kiskundorozsma captured in the period of 1976—1977 an outstandingly great proportion of scavenger elements (80 174) as shown in Fig. 20, while the obstant elements (7466),



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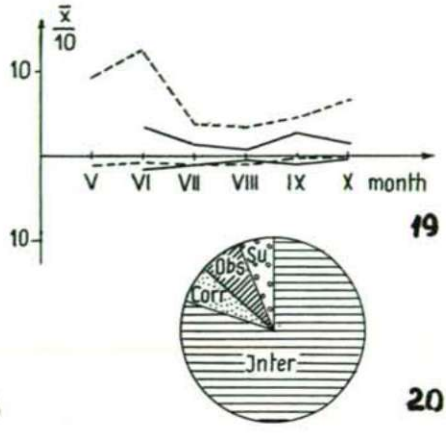

19 20

Fig. 18. The average specimen number of Diptera. — Fig. 19. The sustinent element: Coleoptera. — Fig. 20. The distribution of animals captured in emergence traps according to mode of life.

Table 5. The monthly distribution of Hymenoptera broken down to superfamilies with regard to obstant, sustinent and corrumpent elements.

	Obstant										Sustinent	Corrumpent
	Inchneumonoidea		Chalcid.	Proctotrup.	Bethyl.	Scoli.	Formic.	Pompil.	Sphec.	Obstant total	Apoid.	Cynip.
	Ichn.	Braconidae										
1976												
VI. 4— VII. 9.	35	48	97	324	—	—	176	6	—	686	—	10
VII. 9.— VIII. 7.	14	4	31	53	—	—	523	11	—	636	—	6
VIII. 7— IX. 3.	8	3	17	18	4	—	94	5	3	152	—	8
IX. 3— X. 4.	16	3	5	8	3	1	40	8	1	85	—	1
X. 4— XI. 8.	2	—	1	—	—	—	3	—	—	6	—	—
VI.— XI.	75	58	151	403	7	1	836	30	4	1565	—	25
1977												
V.6— VI. 6.	20	2	73	103	4	—	—	16	—	218	—	179
VI. 6— VII. 9.	68	—	410	131	1	—	10	13	18	651	—	71
VII. 9 — IX. 6.	32	3	210	75	—	—	15	22	6	363	1	38
IX. 6— X. 7.	13	—	5	14	—	—	5	2	—	39	2	—
X. 7— XI. 4.	6	2	5	1	—	—	2	—	—	16	—	—
1977.												
V.—XI.	139	7	703	324	5	—	32	53	24	1287	3	288
1976+1977	214	65	854	727	12	1	868	83	28	2852	3	313

the corrumpent elements (5572) and the quantity of sustinent elements (5445) was significantly less. The individual elements may be compared with reservations when considering species representation, magnitude and efficiency, for more detailed study is needed, consequently, this present study should only be taken as tentative and orientative in nature.

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COMPLEX ECOLOGICAL INVESTIGATIONS IN A SANDY SOIL GRASSLAND: AIMS AND GENERAL METHODOLOGY

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(Received October 24, 1979)

Abstract

The Department of Zoology of the Attila József University has been carrying out, since 1976 a complex ecological investigation into the sandy soil grassland in the Bugac area of the Kiskunság National Park. In addition to the structural and functional study of the natural grass, the researches also include problems of the perturbation of the ecosystem (grazing, insecticides, fertilizing, water concentration) and of succession.

After a preliminary orientation survey in 1975, members of the terrestrial ecological working group of the Department of Zoology of the Attila József University began in 1976 a complex ecological investigation into a sandy soil grassland in the Kiskunság National Park. For the research work, a two-hectare non-pastured grassland was marked out of a sandy soil of several thousand hectares in the Bugac area of the National Park.

The area is divided into two terrains: the deep errwind-furrows formed by the wind and the tops of sand-hills forming a higher terrain. In the wind-furrows, the effect of environment is more humid, in the soil the ratio of the desiltable fraction is higher. The soil of sand-hills is drier and — in respect of its structural composition — is of drift-blown sand type. The vegetation — with the exception of a few spots — is a closed sandy soil grassland. The plant cover on the highest parts of the sand-hills is *Festucetum vaginatae*, more below, in very small spots is *Astragalo-Festucetum rupicolae (=sulcatae)*, but the most part of the higher terrain is covered with *Potentillo-Festucetum pseudovinae danubiale*. In the wind-furrows, the most important assotiation is *Molinio-Salicetum rosmarinifoliae*, here and there with the fragments of *Schoenetum nigricantis*. In the graze part of the grassland, *Potentillo-Festucetum pseudovinae danubiale* is dominant.

The complex investigation into the nature-close grassland-ecosystem mean both thematical and methodological complexities. In this sense our aim is to explore the most important structural characteristics and key-processes of the grassland ecosystem. The main programme of the structural investigations is to study the single elements (phytocoenosis, zoocoenosis, physical conditions) of the ecosystem, including the qualitative-quantitative conditions. When planning the functional investigations we were led by two points of view: to know the energy-flow of the system and to investigate into the regulation mechanisms of the popula-

tions that are of key-importance in respect to the single energy levels, as well as to the ecosystem.

Apart from the above mentioned basic research activity, our work included some practical points of view as well. In this respect, the following themes were contemplated:

1) the effect of grazing on the structural and functional peculiarities of the system;

2) the effect of intensive fertilization;

3) the effect of insecticides;

4) the effect of increasing the water-supply. The latter is justified by the fact that water deficiency is the pessimal ecological factor in the whole area. By terminating this, some changes may be induced in the system. The speed and direction of these changes is not only perturbed but will probably give important information on the stability of the starting system as well. From theoretical point of view, too, we expect some remarkable results from studying the succession, to be carried out on a grassland which will artificially be forced into a pioneer ecological phase.

Our aims have some nature conservation aspects as well: as this area is part of the National Park, these investigations may also give some instruction as to which effects the system can undergo without changing the most important characteristics of the system and what kinds of intervention are necessary for preserving similar grasslands in a natural or almost natural state.

The high number of partial tasks connected with realizing the set aims are coordinated by four members of the ecological working group but they cannot manage this work entirely. Therefore, four amateur research workers, students of the Department of Botany of the Attila József University, are involved into this work, as well. The research work is carried out by 16 persons who spent in the years 1976—1979, so far, about 380 field days in the area. The mass of material and facts collected for elaboration is very large, for instance, the insect material is until now more than 100.000 specimens.

In accordance with our aims summarized above, we started the elaboration of the following subjects:

1) Study from among the exigences the microclimate and soil structure (Department of Botany, Attila József University; GALLÉ, GYŐRFFY);

2) Measurement of the phytomass, and its annual changes has been carried out since 1977 and the phytocoenological survey of the area began, as well (Department of Botany, GYŐRFFY, GALLÉ, KOVÁCS);

3) The qualitative-quantitative exposure of the basic fauna (MÓCZÁR, GALLÉ, GYŐRFFY);

4) From among the phytophagous populations, the ecological analysis of the Cicadinea, Orthoptera, Heteroptera and Lepidoptera groups. In the first two groups, according to energetic points of view, as well (GYŐRFFY);

5) From among the carnivores, the regulative factors and role of Formicoidea populations, as well as the structural analysis of the Araneidea and Lacertilia groups (GALLÉ);

6) The density relations and energetic role of the decomposing Isopoda and Diplopoda populations were exposed, the investigation into the Oribatei and Collembola groups is carried out at present (HORNUNG);

7) From among "sustinent" groups which are important for preserving the vegetation, the study of Apoidea has been carried out according to structural points of view (TANÁCS);

8) From 1977, the effect of grazing and fertilizing has been investigated at a phytoecological level. Our zooecological investigations have included, since 1978, the grazed areas, as well. In 1979, we began to study the effect of insecticides and in 1980, we begin the effect of fertilization and water concentration on animal communities (GYŐRFFY, GALLÉ, Department of Botany);

9) From among the regulating mechanisms of the natural system, the study of the subsystems: plant — phytophaga (Orthoptera, Cicadinea); phytophaga — Carnivora (Cicadinea, Diptera — Formicoidea, Araneidea) and Carvinora — Carnivora (Araneidea — Formicoidea) has been carried out (GALLÉ, GYŐRFFY).

From the investigations until now, three theses (FERÓ, 1977; FARKAS, 1978; KISS, 1979), one university doctoral thesis (HORNUNG, 1979) and one thesis for the candidature of the Hungarian Academy of Sciences (GALLÉ, 1979) were made. In the papers, dealing with the details of the subject, and to be published in the future, the designation "ecosystem of a sandy soil grassland" takes place.

In order to make the research work still more complex, we wish to extend our investigations into the (at present non-studied) following subjects, as well: chemistry of the soil, biochemical cycles, cryptogamous plants, microdecomposing organisms, a more detailed investigation into Diptera, Coleoptera, Hymenoptera, Aphidinea and Physopoda groups. In addition to these, we expect some results from the comparison with similar material of alkali areas (MÓCZÁR and BÍRÓ 1980).

The Kiskunság National Park Directory has been very helpful in our investigations, apart from placing the area at our disposal. Since 1978, our work has been carried out in the framework of a research agreement, with the pecuniary assistance of the Hungarian Academy of Sciences. We wish to express our gratitude to both organs.

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SITUATION OF ETHNICAL-ANTHROPOLOGICAL RESEARCHES INTO THE HUNGARIAN POPULATION AND THE TASKS OF THE FUTURE

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Abstract

In a report, delivered at Meeting 200 of the Anthropological Section of the Hungarian Biological Society, the author summarized the problems connected with the anthropological research into the adult population of present-day Hungary. In the present work — using this material — he is outlining the tasks promoting the further development of the determined research theme. He determines these as follows: Determination of the aims of research, realization of the representative sampling, elaboration of the fact-finding programme, marking out of the geographical areas of research, realization of the elaboration by means of electronic computers, the cooperation of experts.

Every nation endeavours, in some form depending on the level of her social development, her cultural demand and erudition and, last but not least, on her economic conditions, to preserve, or to prove worthy of, the traditions of the past. The expression "the traditions of the past" is, however, a very vague notion, containing the historical past, folk art, several aspects of the social superstructure and may include even man himself.

The preservation of all these traditions is undertaken by more than one division of learning, thus by archaelogy, history, ethnography and, in our opinion, this is to be done by anthropology, as well.

The preservation of the traditional material of knowledge or relics for the man of future cannot be and is not independent of the social background people are living in. With another expression: not all knowledge, spiritual or objective relics may call for respect and preservation. To decide the extension of this demand, much depends upon the erudition and social maturity of the researchers, scholars or scientists. The vanguard fighters in this work have always and everywhere been the progressive research workers and intellectuals who took up and understood the idea of development. And this will be so in the future, as well.

If we try to specify a little more, how in Hungary this activity of preserving traditions has developed, looking at it in a certain perspective, and particularly in our days, we can establish that this work has been promoted by our State with a developed network of museums, with the work of renowned archaelogical and ethnographical researchers, with decrees of legal force, with setting objectives as main research works, with public support and subvention. This research work enjoys a serious material subsidization. But if we want to express ourselves more exactly, we should perhaps rather say that all these conditions, the spiritual and material productions

of man primarily ensure the preservation of human environment. But we have not paid, as yet, so great attention, even in our days, to a massive anthropological or humanbiological cognition of man: at least not so great an attention as we should and could have done.

It seems to me, therefore, that the man of the next century will be able to collect from the material of the stores of museums, the libraries every knowledge, with the help of which he can form a reliable picture of the work, life and activity of the present-day Hungarian man. It is questionable, however, whether he obtains such a reliable picture of man himself, as well. We think, unfortunately, that we must give — at least for the moment — a negative answer.

This establishment in itself does, however, not say anything if we don't try to find the causes of this and the possibilities of a solution.

It would be very wrong to allege that the cause is that the research into the population in Hungary had no historical precedents. It is namely enough to cast a glance into our anthropological bibliographies. It turns out immediately that there are some data on the study of the living population already from the end of the 18th century. The work of Z. HUSZTI (1781) indicates the turning of attention towards the living man. This is followed by the reports of JÁCINT RÓNAY (1846), LÖHER (1874), P. HUNFALVY (1880), S. SCHEIBER (1881) on the characters of the living Hungarians. And this list could be continued.

This interest got a thoroughly unambiguous formulation in the third part of the last century. Namely: what the Hungarian is. It could also be said, what the difference is between Hungarians and other people.

In the beginning of the present century, and then in its first third, this formulation unambiguously turned into the direction, of which the knowledge in a noble sense was only the nucleus. Its true aim would rather have been to "prove" superiority. Owing to the social background then (stirring up chauvinism, irredentism), we need not be surprised at this, even if we thoroughly disapprove this tendency today. It is only surprising that this direction had any followers at all, although it is true that primarily not among the anthropologists.

After the Liberation, this situation has essentially changed. In this place, however, we don't want to touch upon this in detail. The results achieved since then are dealt with in several publications.

As the way of looking, the social background and demands changed, the way in which we could promote the knowlege of up-to-date outlook of the present-day population of Hungary has not changed.

It is to be noted here that it is, in our opinion, more correct to speak of the inhabitants or population of Hungary and not only the research into, knowledge of, the Hungarians. The cause of this is that the present-day population of Hungary speaks not only the Hungarian mother tongue. And at the same time, several people with Hungarian as a mother tongue (and not at all of insignificant number) live outside the national boundary. We have, unfortunately, not much possibility to recognize these anthropologically.

The causes of the weak development of the branch of the Hungarian anthropology, the ethnical anthropology, which we see at present, is nevertheless not to see first of all on ideological territory. The cause may first of all be looked for in the outlook partly of the researchers of our special branch of studies, partly of those of the related sciences. According to us, there are namely not exploited, as yet, the

possibilities of the interdisciplinary research work. The common subjects are not looked for by the workers of any study in a suitable degree. And it is also a fact, unfortunately that the results are realized on the basis of the individual idea of researchers and thus the force behind any cooperation is not exploited in due degree.

This is proved by the publications, too, which render accounts of the results of investigations carried out not by research teams but in largest part by individuals. It occurred also sometimes that, on a few occasions, some research groups stopped in a minor settlement, carrying out there efficient, or perhaps sometimes even too efficient, research work (Ivád, Turricse). But we have not found any trace that their aim would have been the systematic knowledge of the whole population of Hungary — which would have demanded, of course, some serious material support as well. On the other hand, the investigations of such a purpose can be included well, according to us, in historical, local or regional historical researches, of which we can find individual examples (Vésztő, Orosháza, Tápé, Gyoma). The latter ones can, at any rate, be considered as only individual initiations, as yet, and have so far been realized mainly on the territory east of the river Tisza, in the area between the Danube and the Tisza rivers, and in North-Eastern Hungary. These results are very valuable, useful but they mean only a drop in the sea.

Why do we emphasize the necessity of recognizing the whole population of Hungary? We do this because the tendency of the ways of production, the increase of urbanization and also several other social processes is to put an end to the rural, sometimes endogamous, communities. After not a too long time, communities of this type cannot be studied any more.

But the realization of a nation-wide research of major volume vould first of all demand a most important collaboration, concentration of forces on the part of archaeologists, ethnographers, anthropologists equally.

The other group of problems — because of which, in my opinion, the knowledge of the population of the present-day Hungary runs into difficulties — is to be looked for in the application of different method so it is not rare, namely, that even today everybody considers his own method as infallible instead of applying real, realizable, up-to-date processes, into which the individual ideas could be embedded. The modern mechanical evaluation — which is doubtless the way of future — today alr eady expects everybody to follow a uniform method of investigation.

It cannot be, namely, doubtful for any specialist that nowadays the main task is not to establish the cephalic index. Science has already got beyond this level and however we see the question, there are just these difficulties, connected with the meaiuring technology and factfinding, the surmounting of which is the most difficult sn the course of the everyday work. Experimentalists do simply not take seriously the sampling activity. In addition to this, the present-day research cannot be satisfied any more with the superficial acquiring of knowledge, it must get an insight into the interior of the man, as well, it must endeavour with somewhat more complicated meand and more thoroughly to get acquainted with the man of our days and describe him in this way. There is no doubt that these problems do not only emerge in Hungary and it is not unimportant, either, that the investigations into the physiological characters, human polymorphisms which are known by the experts, alike the investigations isonzyme, haptoglobin and blood-group constituted considerable help.

At any rate, the manyfold, very ramifying method makes the comparison impossible already in advance, particularly if we take separately into consideration the

methods studying the metric, morphological and physiological characters, to say nothing of the way of evaluation.

It also belongs to the methodological problems that the samples are not representative, the distribution is not uniform in respect of the whole territory of the country and the themes dealing with studying young people and grown-ups are separated at the investigations into the inhabitants of settlements.

A further task to be solved would be the agreement in methodological questions, the unambiguous indication of tasks (characters to be investigated).

At the same time, it is a fact as well, that even the evaluation of the earlier information, data, collected with rather much work and readiness to sacrifice, has not been done entirely until now.

A following task would, therefore, be the publication of the already existing, collected but not evaluated stock of learning.

We should create, of course, suitable bases for realizing all these tasks. It is to be said that a well, prepared scientific planning alone is not sufficient for this. We need something else, as well. As the researchers are no more expected to have alone professional training and talent but also to be men or women in public life, it is not enough, either, if they publish scientific results in learned journals. It is necessary, too, to create a climate of public opinion, to arouse general interest, in order to enable the continued development. We should need to count on the support of public opinion, as well. That there is such an effort, or at least its germs can be found, is proved by the initiations connected with the Hungarian local monographs.

When we recognize our possible infirmity, backwardness, we should also look for the objective and subjective eliciting causes. Some of these were already mentioned above. But there is one which is worth while being analysed separately. This is the problem of the education and training of specialists.

We don't think that alone the Hungarian anthropology has some difficulties in this area. It may be said rather generally that the special expert training of high demands and the formation of the consequently created scientific competition are still unsolved problems in the domain of anthropology. On the other hand, many examples can also be found for what kind of solutions they try to surmount this difficulty in the single countries, and not without any success. The Hungarian education of anthropologists is, however, entrusted — at present and it had been earlier, too — to chance. Our undergraduates are today more captivated and attracted by molecular biology, biochemistry than by anthropological problems, although these don't exclude each other. Moreover, a teaching staff of small enough number are dealing with educating the future anthropologists and even these are specialized. This means that our students can only become acquainted with some domains of fetail of anthropology so that it can later become a basic point of departure at the beginning of a scientific career. This may also be the cause why some research places abroad that some decades ago were very backward, go today already very much before us.

It would, of course, hardly be possible to carry out in a small country such a training as that of the Lomonosov University in Moscow even today. The instruction of about thirty different special subjects, connected with anthropology, and the about 19-week long practical training, spent in the field, presuppose a serious spiritual background. We have not the conditions of an education like this. But this is perhaps not necessary, either, because it is possible that Hungarian undergraduates

take part in such a thorough-going education in universities abroad. It is a much greater problem that post-graduate education is not solved, as yet, which could be one of the main promotors of the further development.

It is not questionable, therefore, that one of the most serious tasks — which is n connection not only with the research of the now living population but with the igeneral development of the whole Hungarian anthropology, as well, is the training iof specialists at high level, insuring, replacing new specialists. To this, it is highly amportant, to popularize the scientific results, to arouse interests towards the specilized branches of learning.

After mentioning these few general problems, we could not formulate better the tasks of future than we did this already earlier, indicating our tasks as follows:

(1) We should unambiguously determine the aims of the anthropological investigations of the living population.

(2) In case of investigations, representative sampling is to be realized.

(3) At selecting the characters, two sorts of programmes should be elaborated, taking into consideration the individual numbers of the rural and town populations; namely:

— a detailed programme comprising several characters, the aim of which would primarily be to reveal the regularities of the inheritance of characters; this could be realized in case of minor communities; as well as:

— a programme comprising fewer characters but taking into consideration the peculiarities of town environment, which could be carried out in a comparatively short time even in case of larger communities, applying the rules of the sampling processes.

(4) We shall elaborate — taking into consideration the density of population — a scientifically founded plan, which terminates the disproportionatedness of the fields investigated and not-investigated.

(5) We should change over — changing first of all the structure of the collecting list — to the calculator elaboration, according to uniform biometric points of view.

It is proved by the scrutiny of the results of the ethnical investigations that the volume of the work carried out so far is not negligible. But the condition of achieving some results in the future that can be accepted for the universal science, as well, may only be the thoroughgoing planning, common work and the appropriate guiding. In other fields of the scientific life, but even in other branches of biology, new methods are more and more widely applied. This demands not a little material sacrifice. The achieving of this aim can be realized, at any rate, only if we produce the necessary, usable results demanded by the society. The representatives of anthropology ought, therefore, also to understand the voice of times: if we fall behind the speed of development determined by other sciences, this may involuntarily result in arrears in the special branch and, within that, in the ethnical anthropology.

The tasks can be outlined clearly enough but the development in science can only be achieved with cooperation of the man.

Both lectures, delivered at Meeting 200 of the Anthropological Section of the Hungarian Biological Society (namely: "Humanbiological investigation into the human populations", as well as the present abstract of my report) may only mean the elucidation of the same problem from two directions; because it would be not justified to speak separately of the humanbiological and ethnical investigations into the living human communities.

On the other hand, the report, serving for a basis of the present paper, affected in some respects certain questions, too, which also took part in the other lectures delivered there. As the lectures were made independent from one another, touching different special fields of anthropology, repetitions mean a stronger manifestation of the existing problems. It is not probable, namely, that these coincidences, seeming to be incidental, could be attributed to the barrenness of mind of the lecturers. We should rather be optimist and consider these coincidences assigns of a spiritual agreement between the Hungarian anthropologists.

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ANTHROPOLOGICAL CHARACTERISTICS OF 24—60 YEAR OLD GROWN-UPS IN HUNGARY

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Abstract

The authors summarized the results of some anthropological publications of different other authors concerning 16 546 adult individuals of 29 Hungarian settlements. On the basis of this, they make known the characterization considered by these as valid in respect of Hungarians living in the Great Hungarian Plain.

The summary was carried out for males and females in the age-group of 24—60 years-old persons.

They discuss the summarized parameters of eleven metric characters, seven indices, eye-colour, hair-colour, as well as the summarized parameters of the taxonomical analysis.

On the basis of the data available, they give the metric characters for males and females and the mean sigma values of indices.

Introduction

In our paper we have contracted the ethnical anthropological data published in the last 23 years concerning 16 546 adult individuals, in order to be able to give a general characterization, on the basis of the information we have, of the present-day Hungarian population of the Great Plain.

In the course of our work, we have chosen the classification into a rather wide age-group (between 24—60 years), because the arrangement in age groups differs from one another in the works of the single authors and the calculation of the common parameters came up, therefore, against a difficulty.

Material of the investigation

In the paper the samples of the inhabitants of 29 settlements are contracted. In Table 1, the site of research, the name of the publishing author, the years of the fact finding work and publication, as well as the sample sizes are given. The original publications connected with the samples taken into consideration are recited in the list of references.

It manifests itself unambiguously on the basis of the knowledge of the Table and of the map of Hungary that the survey concerning grown-ups only comprises the

area lying between the Danube and Tisza rivers, the territory east of the river Tisza and Northern Hungary. About Transdanubia, i. e. the territory west of the river Danube, we have no recent data. Correspondingly, our establishments to be discussed in the following, cannot be considered as valid is respect of the whole Hungarian population.

From the Table and evaluation some samples, not published, as yet (e. g., Békés) or with incomplete data (e.g., Biharkeresztes, Szabadszállás, Benk) are missing. The latter samples concern nearly 1500 further persons.

The sample of Kecskemét is similarly missing from the contracted material because in this case the parameters were given by the author contracting all the individuals older than 24 years into one sample.

There are also missing from the material to be discussed the data of those older than 61 years whose number is almost 2000.

In the single Tables different sample sizes are given as characters, because not the same sizes were measured by every author and, therefore, there are some samples, from which certain characters are missing.

It must also be referred to that in case of the sample from Ivád those belonging to the age-group 20-56, and in that from Turricse those belonging to the group 53—59 year old persons have got into the contracted samples.

Method of investigation

The partial samples were taken into consideration on the basis of the given parameters.
In case of characters common arithmetic means were calculated on the basis of the formula:

$$\bar{X} = \frac{n_1 \cdot \bar{x}_1 + n_2 \cdot \bar{x}_2 + \ldots + n_m \cdot \bar{x}_m}{n}$$

where $\bar{X}$ is the common arithmetic means of sample number m, $n_1 \ldots n_m$ are the sizes of the single samples number m, $\bar{x}_1 \ldots \bar{x}_m$ are the arithmetic means of the single samples number m,
n is the contracted sample size of samples number m.

In case of standard deviations a common deviation was calculated, similarly to the mean, by the help of the formula:

$$S^2 = \frac{n_1(s_1^2 + d_1^2) + n_2(s_2^2 + d_2^2) + \ldots + n_m(s_m^2 + d_m^2)}{n_1 + n_2 + \ldots + n_m}$$

where:
s^2 is the common square deviation of the contracted sample,
$d_1^2 \ldots d_m^2$ is the square deviation of the single samples of number m from the common arithmetic mean,
$n_1 \ldots n_m$ are the sizes of the single samples number m,
$s_1^2 \ldots s_m^2$ are the square deviation of the single samples number m.

As in case of the samples from Bükkszék, Karcag, Jászszentandrás, Bugac, Kunszállás, Ivád, the square deviations in the age-group of the 24—60 years old persons are not at our disposal, they could not be taken into consideration in establishing the contracted standard deviation.

We regard the common standard deviation obtained by us as the mean sigma-values of the characters of the 24—60 year-old males and females in Hungary.

From the publications being at our disposal we could take into consideration the following characters (size numbers according to Martin):

1) Stature
23) Sitting height
1) Maximum head length
3) Maximum head breadth
4) Minimum frontal breadth
6) Zygomatic breadth
8) Bigonial width
13) Nose breadth
15) Head height
18) Morphological facial height
21) Nasal height
45) Head perimeter

From among the corresponding indices of the enlisted measurements the following are mentioned in the publications of the single authors:

3:1 Cephalic index
15:1 Height-length index
15:3 Height-breadth index
4:3 Transverse cephalofrontal index
18:6 Facial index
8:6 Jugomandibular index

13:21 Nasal index.

Hair-colour was determined by the researchers according to Fischer-Saller's range of hair-colours. In case of eye-colours there was a difference in methods. In case of these, therefore, a rearrangement of data became necessary.

The taxonomical analysis did not take place in a uniform way, either, althought Lipták's taxonomical process was mainly applied by the authors. The greatest difference appeared in this respect — owing to differences in the opinions — between the works of Henkey and those of the other authors. We have, therefore, presented the two sorts of determination separated in our Table.

Calculations were carried out by research fellows Mrs. Attila Máté and Zoltán Vass, according to their programmes, with an R-40 type computing machine. We wish to express our gratitude for their work in this way, as well.

Finally, we have carried out the analysis of the Penrose-distance with an electronic calculator. The results of this are, however, not touched upon in this paper.

Results of the investigation

In Table 2, the sample-size of the enumerated characters of the 24–60 year-old males and females, the extent of their variations and arithmetic means are given. The two sexes can be characterized according to the data of the Table as follows:

a) Males: Their stature is supra-medium, their head, on the basis of absolute measurements, is long, mediumbroad and high, their front is broad, their face is broad and medium high, their lower mandible is very broad.

According to the indices, they are characterized by brachycephalism, metrio-acrocephalism, meso-euryprosopism and hyperchamaerrinism (Table 2).

b) Females: According to the arithmetic means, their stature is medium, sub-medium, their head is long, mediumbroad and high, resp. medium-high. Their front is broad, their face is broad and medium-high, the lower mandible is broad (Table 2).

On the basis of indices, they are characterized by brachycephalism, metrio-cephalism, meso-euryprosopism and leptorrhinism.

The characterizations, which can be given concerning both sexes on the basis of means, are therefore not very different. Some difference can only be observed concerning stature, the bigonial width, the height-breadth index and the nasal index, to a lesser extent.

In Table 3, we have given the mean sigma-values of characters — divergently from Howells — in respect of both sexes. The calculated sigmas — as it was to be expected — generally approach Howells' values but in some cases, they also differ from those, more or less. The greatest difference is in the nasal index.

The distribution of the main measurements and indices is indicated, according to sexes, in Tables 4 and 5.

It is shown by the sigma-values of the Table that the deviation values should be given concerning both sexes separately and it is not at all right, for instance, in case of samples originating from the population in Hungary, to compare these with Howells's values. Although the sample size of our total sample is small if compared with the whole Hungarian population, we nonetheless regard the application of the sigma-values obtained on the basis of these, to the comparison of the Hungarian samples more correct than to compare them with Howells's data.

In Table 6, information is given on the distribution of eye-colours. The 13095 data of the contracted sample shows a difference according to sexes. Eyes of light

Table 1. A survey of the material of investigation.

Serial number	Site of the investigation	Author(s)	Year of publication	Year of the investigation	Sample size
1	Ivád	Nemeskéri	1953	1939—42	523
2	Szabolcs	Thoma	1957	1953	249
3	Szeremle	Henkey	1961		484
4	Fülöpszállás	Henkey	1961		500
5	Homokmégy	Henkey	1962		485
6	Nagybaracska	Henkey	1962		415
7	Szabadszállás	Henkey	1962—63		507
8	Foktő	Henkey	1963—64		291
9	Orosháza	Farkas—Lipták	1965	1963	2001
10	Szakmár	Henkey	1966	1965	535
11	Fajsz	Henkey	1967	1965	460
12	Dömsöd	Kelemen	1968	1963	891
13	Tápé	Farkas—Lipták	1970	1968	725
14	Bugac	Henkey	1973		207
15	Dunapataj	Henkey	1973	1964—65	459
16	Jászdózsa	Henkey	1973		462
17	Kunszállás	Henkey	1978		307
18	Mezőkövesd	B. Bodzsár—Eiben	1973	1971	164
19	Vésztő	Farkas—Varga	1973	1972	903
20	Jászboldogháza	Henkey	1974	1972—73	281
21	Lajosmizse	Henkey	1974	1970—71	610
22	Turricse	M. Szilágyi	1974	1971	542
23	Bükkszék	Henkey	1975		410
24	Gyoma	Farkas—Hunya—Varga	1975	1974	1457
25	Gyöngyöspata	Henkey	1975	1972	302
26	Jászszentandrás	Henkey	1975		343
27	Karcag	Henkey	1975	1972—73	315
28	Mátraderecske	Henkey	1975	1972	165
29	Nógrád megye	Henkey	1976	1973—74	1553
				Together:	16 546

colour occur in case of both sexes in only about 20 per cent. Apart from this remark, in males the mixed, in females the dark colour prevails. This means that not more than every fifth Hungarian male or female has blue eyes and in males first of all the greenish, in females the rather brown eye-colour occurs.

Table 2. Some parameters of the characters of the 24—60 year-old persons.

Character	Males			Females		
	n	*w*	$\bar{x}$	*n*	*w*	$\bar{x}$
Stature	5954	165.9—171.4	168.04	5319	153.8—160.0	153.33
Maximum head length	5989	183.8—190.0	187.39	5337	174.3—182.1	178.70
Maximum head breadth	5985	153.4—162.1	158.86	5337	147.8—155.9	153.41
Bizygomatic breadth	5976	124.3—148.4	144.31	5337	118.8—140.4	137.67
Morphological facial height	5985	120.0—124.1	121.24	5338	109.2—116.0	111.62
Minimum frontal breadth	5887	106.5—114.9	111.15	5209	104.0—111.0	108.15
Bigonial width	5897	110.2—113.4	111.69	5209	102.3—105.7	104.56
Nose breadth	5782	34.2— 37.0	35.69	5086	31.9— 33.8	32.62
Nasal height	5777	52.0— 55.9	54.11	5084	47.9— 53.0	50.10
Head height	3680	119.5—135.0	129.90	2963	115.9—131.4	124.29
Sitting height	5049	86.3— 89.5	87.68	4323	81.6— 84.5	83.31
Cephalic index	5972	83.6—87.2	84.87	5330	84.6—88.1	85.89
Facial index	5955	82.7—97.2	84.09	5330	78.2—93.1	81.23
Nasal index	5866	63.0—68.0	66.21	5199	61.0—69.5	65.24
Transverse cephalofrontal index	2164	68.7—70.4	69.70	1396	69.1—70.8	69.84
Height-length index	2318	64.9—72.7	70.70	1593	66.6—73.6	70.92
Height-breadth index	2315	75.8—86.1	84.14	1593	77.6—86.4	83.30
Jugomandibular index	2255	77.3—81.0	78.15	1517	76.3—77.9	76.95

Table 3. Comparison of the mean sigmas of characters.

Characters	Howell's data	Hungarian data	
		Males	Females
Stature	5.8	6.1868	5.5556
Sitting height	—	3.3517	3.0814
Head length	6.2	6.2026	5.4238
Head breadth	5.2	5.7023	5.0215
Minimum frontal breadth	4.9	4.8789	4.3316
Bizygomatic breadth	5.3	6.1152	5.4658
Bigonial width	5.8	6.1541	5.1295
Nose breadth	2.9	2.7832	2.7565
Morphological facial height	6.4	6.7838	5.9280
Head height	—	6.1947	5.8054
Nasal height	3.8	3.6905	3.2484
Cephalic index	3.4	3.4191	3.0381
Height-length index	—	3.7910	3.8068
Height-breadth index	—	4.5810	4.3677
Morphological facial index	5.1	5.1392	4.6900
Nasal index	7.8	6.7727	6.1914
Transverse cephalofrontal index	—	3.3565	3.1434
Jugomandibular index	—	4.4980	4.0449

Table 4. Distribution of the main measurements and indices. 24—60 year-old males.

Measurement number	Character	Classing	Designation	n	p.c.
1	Stature (Martin)	×—159.9	Short	428	9,80
		160—163,9	Sub-medium	691	15.83
		164—166.9	Medium	737	16,88
		167—169.9	Supra-medium	826	18.92
		170—179.9	Tall	1555	35,62
		180—×	Very tall	129	2.95
			Sum total	4366	100,00
1	Maximum head length	×—177	Short	195	6.31
		178—185	Medium-long	969	31.36
		186—193	Long	1423	46.05
		194—×	Very long	503	16.28
			Sum total	3090	100.00
3	Maximum head breadth	×—147	Very narrow	45	1,46
		148—155	Narrow	642	20,78
		156—163	Medium broad	1687	54,61
		164—×	Broad	715	23.15
			Sum total	3089	100.00
6	Bizygomatic breadth	×—133	Narrow	154	4.54
		134—141	Medium broad	804	23.72
		142—150	Broad	1876	55.36
		151—×	Very broad	555	16.38
			Sum total	3389	100.00
18	Morphological facial index	×—117	Low	925	27.25
		118—126	Medium high	1726	50.85
		127—135	High	679	20.01
		136—×	Very high	64	1.89
			Sum total	3394	100.00
3:1	Cephalic index	×—75.9	Dolichocephal.	35	0.82
		76—80.9	Mesocephal	522	12.22
		81—85.9	Brachycephal	2009	47.01
		86—×	Hyperbrachyc.	1707	39.95
			Sum total	4273	100.00
18:6	Facial index	×—78.9	Hypereurypr.	663	15.18
		79—83.9	Euryprosope	1586	36.32
		84—87.9	Mesoprosope	1184	27.11
		88—92.9	Leptoprosope	712	16.30
		93—×	Hyperleptopr.	222	5.09
			Sum total	4367	100.00
13:21	Nasal index	×—54.9	Hyperleptorr.	163	3.69
		55—69.9	Leptorrhin	2993	67.84
		70—84.9	Mesorrhin	1213	27.47
		85—×	Chamaerrhin	44	1.00
			Sum total	4416	100.00

Table 5. Distribution of the main measurements and indices. 24—60 year-old females.

Measurement number	Character	Classing	Desingation	n	p.c.
1	Stature	×—148.9	Short	299	8.39
		149—152.9	Sub-medium	620	17.40
		153—155.9	Medium	719	20.17
		156—158.9	Supra-medium	731	20.51
		159—167.9	Tall	1108	31.09
		168—×	Very tall	87	2.44
			Sum total	3564	100.00
1	Maximum head length	×—169	Short	122	4.03
		170—176	Medium-long	834	27.58
		177—184	Long	1607	53.14
		185—×	Very long	461	15.25
			Sum total	3024	100.00
3	Maximum head breadth	×—141	Very narrow	27	0.89
		142—149	Narrow	522	17.26
		150—157	Medium broad	1794	59.30
		158—×	Broad	682	22.55
			Sum total	3025	100.00
6	Bizygomatic breadth	×—125	Narrow	76	2.76
		126—133	Medium broad	394	14.33
		134—142	Broad	1677	60.98
		143—×	Very broad	603	21.93
			Sum total	2750	100.00
18	Morphological facial index	×—108	Low	734	26.69
		109—117	Medium low	1511	54.94
		118—126	High	482	17.53
		126—×	Very high	23	0.84
			Sum total	2750	100.00
3:1	Cephalic index	×—76.9	Dolichocephal	6	0.21
		77—81.9	Mesocephal	247	0.65
		82—86.9	Brachycephal	1445	50.59
		87—×	Hyperbrachyc.	1158	40.55
			Sum total	2856	100.00
18:6	Facial index	×—76.9	Hypereurypr.	500	19.14
		77—80.9	Euryprosope	882	33.75
		81—84.9	Mesoprosope	776	29.70
		85—89.9	Leptoprosope	376	14.39
		90—×	Hyperleptopr.	79	3.02
			Sum total	2613	100.00
13:21	Nasal index	×—54.9	Hyperleptorr.	146	4.05
		55—69.9	Leptorrhin	2638	73.13
		70—84.9	Mesorrhin	808	22.40
		85—×	Chamaerrhin	15	0.42
			Sum total	3607	100.00

Table 6. Distribution of eye-colour.

Sex / Eyecolour	males		females		together	
	n	p.c.	n	p. c.	n	p.c.
light (la-2b)	1747	22.78	1115	16.92	2862	19.85
mixed (3—11)	3242	40.71	2584	39.69	5826	40.20
dark (12—16)	2069	36.47	2338	43.38	4407	39.93
Sum total:	7058	99.96	6037	99.99	13095	99.98

Note: The data of Ivád, Szabolcs and Turricse are missing from the Table. Further on, the total case number of males is 7059. In the Table, the total case number is nevertheless 7058, because in the partial sample from Foktő one male had eyes of dissimilar colours.

On the distribution of hair-colour we have some data from Table 7. The fair hair is very rare — its frequency is below 5 per cent. The brown, resp. black hair-colour are, at the same time, most frequent.

In Table 8, the results of the taxonomical analyzes are surveyed. As already mentioned, Henkey's determinations somewhat differ from those of the other authors. He namely considers the variety Cromagnoid-C as Turanid. Accordingly, we get at him the 30 per cent Turanid frequency. But it is absolutely necessary to refer to that — on the basis of the analysis of Lipták's taxonomy — the type named Turanid is a Europomongolid variety and the above mentioned high frequency of such a variety cannot be demonstrated in the present living Hungarians.

Summary

The authors summarized some anthropological data, published earlier by different authors concerning 16 546 adult individuals from 29 Hungarian settlements. On the basis of this, they have given the summarized parameters of some males and females, in case of 11 metric characters and 7 indices. They have summarized the data concerning eye-colour and hair-colour, as well as the results of the taxonomical analyses.

They report on the mean-sigma values, calculated to the metric characters and indices, separately concerning males and females.

Table 7. Distribution of hair-colour.

Sex / Haircolour	males		female		together	
	n	p. c.	n	p. c.	n	p. c.
fair (A—L)	234	3.95	265	4.14	499	4.05
light brown black (M—Y)	6923	95.70	5877	95.38	12 800	95.54
red (I—VI)	52	0.34	48	0.48	100	0.41
Sum total:	7209	99.99	6190	100.00	13 399	100.00

Note: Data of Szabolcs and Turricse are missing from the Table.

They have established that there cannot be demonstrated any essential difference — apart from the sexual dimorphism — between the two sexes in respect of the anthropological characteristics.

There is, however, a considerable difference in the taxonomical determination of the different authors.

The sumary has referred to, as well, that the investigation of the present-day living Hungarians has only been realized, so far, in the area lying between the Danube and Tisza rivers, on the territory east of the river Tisza and on that of Northern Hungary. About Transdanubia, i. e. the territory west of the river Danube, we have no recent data. Corresponding to this, the characterization, obtained on the basis of the summary, cannot be considered as valid in respect of all the Hungarians.

Table 8. Comparison of the percentage of the main taxonomical categories.

Taxonomical category	On the basis of Henkey's investigations	Not on the basis of Henkey's investigations	Together
Cromagnoid-A	0.18	2.56	0.71
Cromagnoid-B	3.69	20.97	7.53
Cromagnoid-C	0.00	7.38	1.64
Nordoid	0.30	3.58	1.03
Mediterranian	5.02	9.93	6.11
Alpine-lappid	2.46	11.65	4.50
Dinaric	5.94	13.31	7.58
Pamirian	5.45	6.53	5.69
Armenoid	9.94	6.34	9.14
Undetermined Brachycephalic	0.00	9.43	2.09
Turanid	29.38	0.04	22.86
Other Europo-mongoloid	0.84	0.30	0.72
Undetermined ones	36.80	7.98	30.40
Sum total:	100.00	100.00	100.00

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NICHE ANALYSIS AND COMPETITIVE STRATEGIES OF GRASSLAND ANTS (PRELIMINARY GOMMUNICATION)

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Abstract

Using the possibilities and methods of niche analysis in six niche components — macrohabitat, size, parasitism, vertical and horizontal microhabitat and daily activity rhythms — two competitive strategies were revealed on grassland ants: 1. strategy of interspecifically aggressive species having higher intraspecific aggressivity thresholds and only scramble-type competition as a rule; 2. interspecifically subordinated, opportunistic species that have strong intraspecific competition, aggressivity and territoriality.

In the course of an ecological analysis of the niches of ants in the grasslands situated mostly on Hungarian Great Plain, the following niche components were studied: 1. macrohabitat: the grasslands meaning biotopes for ants; 2. size of foragers; 3. parasitism: here the presence of socialparasitism and the identity of host sp. were the basis of analysis; 4. vertical microhabitat, i.e. the levels where foragers gather food; 5. horizontal microhabitat: the identity and segregation of foraging areas and 6. activity that means the daily rhythms of foraging. As it can be seen, these niche components do differ from Hutchinson's niche axes (GALLÉ, in preaparation).

Levins' niche breadth (COLLWELL—FUTUYMA, 1971; FEKETE et al., 1976), Whittaker's and Schoener's niche overlap (ABBOTT et al., 1977; FEKETE et al. 1976 etc.), Pielou's average niche overlap (PIELOU, 1972) and Collwell's and Futuyma's (1971) relative weighting factor were used to analyse the niches of ants.

In the course of macrohabitat analysis the populations of 31 ant species were investigated on 40 grasslands representing 15 associations and 28 lower phytocenological categories. For detailed investigation of the two microhabitats and activity, 3 grasslands were chosen *(Festucetum vaginatae-Molinio-Salicetum* komplex, *Salvio-Festucetum* and *Cynodonti-Poetum)*.

The most important results are: 1. The species having otherwise identical niches are segregated in macrohabitat dimension, this fact supports the validity of Gause's law on grassland ants. 2. There are two competitive strategies among grassland ants: (a) the strategy of interspecifically aggressive species having relatively high intraspecific aggressivity thresholds and scramble competition within population; (b) the strategy of species generally subordinated and opportunisitic in the interspecific competition, but they are aggressive intraspecifically and as a rule build monocalic colonies. Belonging to one of the competitive strategies: it is also an important element of the niche of a given species.

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